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FORTY-SIXTH ANNUAL REPORT

OF THE

**NORTH CAROLINA AGRICULTURAL
EXPERIMENT STATION**

CONDUCTED JOINTLY BY THE

NORTH CAROLINA DEPARTMENT OF AGRICULTURE

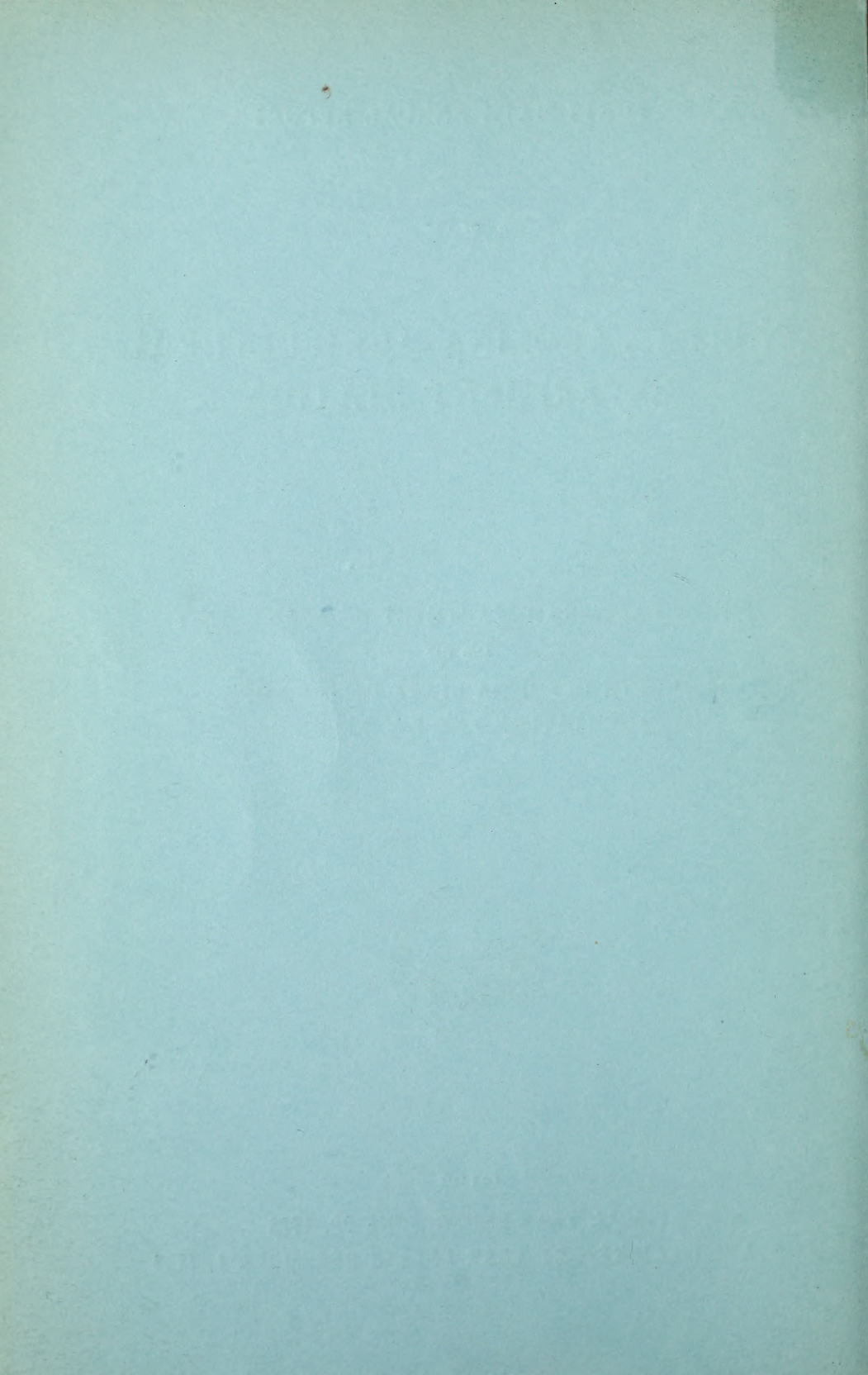
AND THE

**NORTH CAROLINA STATE COLLEGE OF
AGRICULTURE AND ENGINEERING**



FOR THE

**FISCAL YEAR ENDED JUNE 30, 1923
STATISTICAL REPORT YEAR ENDING DECEMBER 1, 1923**



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EXPERIMENT STATION

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AGRICULTURE AND MECHANICAL ARTS

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LETTER OF SUBMITTAL

RALEIGH, N. C., June 30, 1923.

*To His Excellency, CAMERON MORRISON,
Governor of North Carolina.*

SIR:—I have the honor to submit herewith report of the operations of the Agricultural Experiment Station, conducted jointly by the North Carolina Department of Agriculture and the North Carolina State College of Agriculture and Engineering, for the year ended June 30, 1923. This work is under the immediate direction of the "Joint Committee for Agricultural Work," provided for in chapter 68 of the Public Laws for 1913, and amended by chapter 223 of the Public Laws of 1917, and the report is made in accordance with the requirements of the act of Congress, approved March 2, 1887, and known as the Hatch Act.

Very respectfully,

B. W. Wilson

Director.

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STAFF OF THE NORTH CAROLINA EXPERIMENT STATION AND EXTENSION SERVICE

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B. W. KILGORE.....	Director, Experiment Station and Extension Service
F. E. MILLER.....	Assistant Director, Branch Stations
J. M. GRAY.....	Assistant Director, Extension Service
F. H. JETER.....	Agricultural Editor
A. F. BOWEN.....	Bursar
MRS. M. H. HILL.....	Bursar
MISS MARY S. BIRDSONG.....	Secretary to the Director
H. C. EVANS.....	Auditor and Executive Assistant

AGRONOMY

C. B. WILLIAMS, Chief, Division of Agronomy	G. M. GARREN.....	Assistant in Plant Breeding
W. F. PATE.....	S. W. HILL.....	Assistant in Plant Breeding
S. K. JACKSON.....	L. G. WILLIS.....	Soil Chemist
H. B. MANN.....	†W. E. HEARN.....	Soil Survey
E. C. BLAIR.....	†S. O. PERKINS.....	Soil Survey
R. Y. WINTERS.....	W. A. DAVIS.....	Soil Survey
Agronomist in Plant Breeding	S. F. DAVIDSON.....	Soil Survey
P. H. KIME.....	R. C. JUNEY.....	Soil Survey
Assistant in Plant Breeding	Soil Survey	
W. B. LEE.....		

CHEMISTRY

W. G. HAYWOOD.....	Fertilizer Chemist	J. O. HALVERSON.....	In Charge, Feed Control and Nutrition
E. S. DEWAR.....	Assistant Chemist	L. M. NIXON.....	Asst. Feed Control Chemist
Z. P. BRADFORD.....	Assistant Chemist	F. W. SHERWOOD.....	Assistant in Nutrition
C. L. WILLIAMS.....	Assistant Chemist	B. NAIMAN.....	Assistant in Nutrition

ENTOMOLOGY

FRANKLIN SHERMAN.....	Chief in Entomology	T. B. MITCHELL.....	Asst., Inspections and Field Work
Z. P. METCALF.....	Entomologist	J. C. CRAWFORD.....	Asst., Investigations
R. W. LEIBY.....	Asst. Entomologist, Investigations	J. A. HARRIS.....	Asst., Investigations
C. S. BRIMLEY.....	Asst., Investigations	W. B. MABEE.....	Asst., Extension
†C. L. SAMS.....	Beekeeping Extension		

*Members of Joint Committee in Agricultural Work.

†In cooperation with United States Department of Agriculture.

HORTICULTURE

C. D. MATTHEWS.....	Chief, Division of Horticulture
J. P. PILLSBURY.....	Horticulturist
W. A. RADSPINNER.....	Assistant Horticulturist, Pomology
C. F. WILLIAMS.....	Assistant Horticulturist, Research
R. F. PAYNE.....	Extension Horticulturist
H. R. NISWONGER.....	Extension Horticulturist

ANIMAL INDUSTRY

R. S. CURTIS.....	Asst. in Poultry Extension
Acting Chief, Animal Industry Division	J. A. AREY.....Dairy Extension
EARL HOSTETLER.....Swine Investigations	A. C. KIMREY.....Asst. in Dairy Extension
G. P. WILLIAMS.....Sheep Extension	F. R. FARNHAM.....Asst. in Dairy Extension
W. W. SHAY.....Swine Extension	W. L. CLEVENER.....Asst. in Dairy Extension
M. V. HAYS.....Asst., Swine Extension	†H. L. WILSON.....Cheese Manufacturing
B. F. KAUPP.....Poultry Investigations	W. A. GRAHAM.....Cheese Manufacturing
R. S. DEARSTYNE.....	J. O. HALVERSON.....
Assistant in Poultry Investigations	In Charge of Feed and Nutrition
A. G. OLIVER.....Poultry Extension	F. W. SHERWOOD.....Assistant in Nutrition
B. NAIMAN.....Assistant in Nutrition	

PLANT PATHOLOGY

F. A. WOLF.....	Plant Pathologist
S. J. LEHMAN.....	Assistant Plant Pathologist
G. A. FANT.....	Extension Plant Pathologist

DRAINAGE

†F. O. BARTEL.....	Drainage Engineer
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MARKETS AND RURAL ORGANIZATION

B. F. BROWN.....	Chief, Division of Markets
GORRELL SHUMAKER.....	Marketing Fruits and Vegetables
A. V. ANDERSON.....	Rural Credits
†P. H. HART.....	Cotton Grading
JAMES I. JOHNSON.....	Assistant in Cotton Grading
†J. P. BROWN.....	State Warehouse Superintendent
V. W. LEWIS.....	Livestock Marketing
†FRANK PARKER.....	Agricultural Statistician
W. H. RHODES.....	Assistant Agricultural Statistician
THOMAS W. HANCOCK.....	Assistant Agricultural Statistician

BRANCH STATIONS

R. E. CURRIN, JR.....	Assistant Director, Upper Coastal Plain Branch Station
F. T. MEACHAM.....	Assistant Director, Piedmont Branch Station
S. C. CLAPP.....	Assistant Director, Mountain Branch Station
CHARLES DEARING.....	Assistant Director, Coastal Plain Branch Station
E. G. MOSS.....	Assistant Director, Tobacco Branch Station
J. L. REA, JR.....	Assistant Director, Blackland Branch Station

FARM FORESTRY

†H. M. CURRAN.....	Farm Forestry Specialist
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FARM ENGINEERING

E. R. RANEY.....	Specialist in Farm Engineering
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FARM DEMONSTRATION

J. M. GRAY.....	Assistant Director of Extension and State Agent
C. R. HUDSON.....	State Agent, Negro Work
S. J. KIRBY.....	Assistant State Agent, Club Work
J. W. GOODMAN, JR.....	District Agent
E. S. MILLSAPS.....	District Agent
O. F. MCCRARY.....	District Agent
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W. B. PACE.....	District Agent
L. E. HALL.....	District Agent (Negro Work)
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HOME DEMONSTRATION

MRS. JANE S. MCKIMMON.....	State Agent, Home Demonstration
MISS MAUDE E. WALLACE.....	Assistant State Agent
MISS PAULINE SMITH.....	District Agent
MRS. ESTELLA T. SMITH.....	District Agent
MRS. CORNELIA C. MORRIS.....	District Agent
MISS MARTHA CREIGHTON.....	District Agent

*Members of Joint Committee in Agricultural Work.

†In cooperation with United States Department of Agriculture.

FORTY-SIXTH ANNUAL REPORT
OF THE
North Carolina Agricultural Experiment Station

B. W. KILGORE, *Director*
F. E. MILLER, *Assistant Director Branch Stations*
F. H. JETER, *Agricultural Editor*

It has seemed wise in making this report to alter the form of the general summary somewhat for the purpose of calling attention to the many lines of investigative work being conducted by the Experiment Station on its branch station farms. There are seven of these farms in addition to the Central Farm at the State College. In order, these seven farms are: The Swine Station near Raleigh, the Mountain Branch Station near Swannanoa, the Piedmont Branch Station near Statesville, the Tobacco Branch Station near Oxford, the Upper Coastal Plain Branch Station near Rocky Mount, the Coastal Plain Branch Station near Willard, and the Blackland Branch Station near Wenona. On these farms, as well as on the Central farm, the work has been carried along in a satisfactory manner. Progress is recorded in each of the various projects, and many permanent improvements have been made in physical equipment. The Swine Station is a new addition to the research facilities, and was made possible by a donation on the part of the State Department of Agriculture of the old hog cholera serum plant for research work with swine.

Though not occurring during the period covered by this report, the death of Commissioner of Agriculture, W. A. Graham, was a serious loss to the agricultural life of the State. Commissioner Graham died on Christmas Eve, 1923, after fifteen years of service as head of the Department of Agriculture. He was succeeded by his son, W. A. Graham, Jr., on the appointment of Governor Cameron Morrison.

The resignation of Dr. W. C. Riddick as President of the State College and the election by the Trustees of Dr. E. C. Brooks was another important change affecting the official life of the Experiment Station. Dr. Brooks came to the College after serving for some years as State Superintendent of Public Instruction, and with an established record of educational activity behind him.

The only other important change affecting the officials of the station was the election of Director B. W. Kilgore to be Dean of the School of Agriculture at the College, thus unifying and consolidating the agricultural teaching work with that of investigation and extension.

CHANGES IN STAFF

Changes in staff since the last report include the following:

Resignations.—E. D. Bowditch, Assistant Horticulturist, transferred to county agent work in Mitchell County; F. E. McCall, Landscape Garden Specialist; F. T. Peden, Assistant in Beef Cattle Investigations; George Evans, Sheep Specialist, transferred to county agent work in Davie County; J. M. Watts, Assistant in Swine Extension; Stanley Combs, Dairy Investigations; J. M. Workman, Warehouse Construction; T. D. McLean, District Agent, and C. C. Proffitt, District Agent.

Appointments.—Robert Schmidt, Vegetable Gardening; W. A. Radspinner, Pomology; H. R. Niswonger, Assistant Horticulturist; H. Neal Blair, Kraut Specialist; G. P. Williams, Sheep Specialist; W. L. Clevenger, Dairy Manufacturing Specialist; J. W. Goodman, Jr., District Agent; W. B. Pace, District Agent; H. A. McGee, Tobacco Specialist, and A. V. Anderson, Rural Credits.

PUBLICATIONS

Some of the publications prepared by experiment station workers have been issued by the extension division as extension circulars giving information about some particular problem with which the extension specialists were concerned. The experiment station workers have also contributed a number of valuable articles on various lines of investigation that have been used by the press of the State. Only a limited fund is available for publication of experiment station findings, which makes it necessary that these other vehicles be used. The Department of Agriculture has also published as Department bulletins some of the work done by the investigative staff.

During the past year the Department has published the following bulletins as contributions from the Experiment Station:

March, 1923—*Plum Curculio on Peaches.* R. W. LIEBY.

November, 1923—*Fertilizer Experiments with Wheat on Piedmont Red Clay Loam Soils.* By C. B. WILLIAMS and others.

The regular bulletins of the station issued during the past year are as follows:

Bulletin No. 246—*Tobacco Wildfire.* By F. A. WOLF.

Technical Bulletins

Number 22—*Digestive Coefficients of Poultry Feeds and Rapidity of Digestion and Fate of Grit in the Fowl.* By B. F. KAUPP and J. E. IVEY.

Number 23—*Hybridization of Vitis Rotundifolia—Inheritance of Anatomical Stem Characteristics.* By C. F. WILLIAMS.

Number 24—*Nitrification and Acidity of Muck Soils of North Carolina.* By L. G. WILLIS.

Annual Reports

Forty-fifth Annual Report of the North Carolina Experiment Station.
By B. W. KILGORE.

A total of 23,000 copies of these publications have been issued and distributed to the station mailing list. There are now about 17,000 names on the station mailing list, these being divided into a number of small lists classified under subject matter heads.

THE BRANCH EXPERIMENT STATIONS

The Experiment Station with its eight branch stations is favorably situated to render service to farmers all over the State. The Central and Swine Research stations at Raleigh deal strictly with research projects, and some of the more general farm problems. The six outlying stations being located in the principal soil regions of the State, are concerned chiefly with problems of their respective region. The station, as a whole, is an investigational and research agency. It endeavors to solve those problems of present importance to the farmers of the State; it plans new experiments in search of additional facts that will apply to better methods of farming, and it publishes the results of its experiments and studies in order that the teachers of agriculture, extension workers and farmers may make use of these facts in the betterment of agriculture.

CENTRAL EXPERIMENT STATION, RALEIGH

The program of work on this station is to deal with problems of a research nature, as it offers better equipped laboratories for technical studies. Some of the more general farm problems are also dealt with here, leaving those of local importance to one or more of the outlying stations. The station being located at the State College gives the agricultural students the opportunity of studying the different experimental projects under way.

The outstanding research project of the Animal Industry Division is to determine the effect of cottonseed meal upon the growth and reproduction of cows. From this experiment have been obtained some results which will have much influence on the amounts of cottonseed meal that can be safely used in dairy rations. The early results have shown that feeding excessive amounts of cottonseed meal causes abortion, weak calves and soft bone, and that the milk produced from cows receiving such rations fails to produce normal growth with calves.

During the past year the cottonseed meal was supplemented in various ways by the use of calcium carbonate, butter fat, cod liver oil, yeast, mineral steam bone meal and wheat embryo, with the view of determining the cause of the ill effect from feeding excessive amounts of the meal.

The poultry work deals with diseases of fowls, breeding studies, feeding tests, marketing experiments, problems in incubation, and studies of the general pathology of the fowl. Much valuable information has been secured from these tests, which is used by the poultrymen of the State, and in the poultry classes at the State College.

The agronomy tests include seed selection and improvement, variety tests, and fertilizer studies. The information gained here is used in advising general farm practices for the section and class room studies.

SWINE RESEARCH STATION, RALEIGH

The station, comprising seventy-two acres of land, is located just south of Raleigh, and is given over entirely to investigational work with swine. The brick buildings formerly used by the Veterinary Division for making cholera serum have been rearranged to meet the requirements of the swine work and a nutrition barn, farrowing barn, feed barn, and laboratory, which includes room for slaughtering, curing meat, mixing feed, and office, have now been made available. The foreman's dwelling has been remodelled and a new four-room house for labor has been built. A new barn has also been built to house the work-stock and provide room for storing feed and implements. The farm has been arranged into a system of pastures and feeding lots, and as a whole is ideal for swine experimental work.

The problem of "soft pork" is given first consideration. The following projects are being conducted:

To determine the length of time necessary to make pigs soft on peanuts, and the length of time necessary to harden them after they have been made soft.

For effect of various amounts of peanuts on body carcasses, ten pigs sixty to eighty pounds in weight were fed individually for approximately one hundred and fifteen days.

For effect on body carcass of the same quantity of peanuts being fed to each pig, four pigs averaging 125 pounds each were individually fed for about one hundred and ninety-five days.

The adequacy of the protein in peanut meal for supporting growth when fed properly, otherwise a supplemented ration was tried.

For the effect on body carcass of corn and rice feeding following peanut feedings, pigs of weaning age are being used.

To determine the effect upon the carcasses of seventy-five to one hundred pigs which have been fed peanuts or soybeans for eight weeks with a subsequent feeding on corn and tankage for twelve weeks. The results show that pigs fed peanuts or soybeans for eight weeks followed by a feeding period of twelve weeks on corn and tankage did not kill out strictly hard.

Other tests in determining the cost of raising pigs to weaning age (8 weeks) and feeding tests in connection with pasture crops are under way.

The Duroc Jersey breed of swine is used exclusively on the station, and sufficient number of brood sows are maintained to raise all pigs required for the different investigations.

BLACKLAND EXPERIMENT STATION, WENONA

This station is located on a typical area of the black lands which extend from Virginia well down into eastern North Carolina. One of the largest developments of agricultural lands in the last few years has been on these lands. With the drainage canals and lateral ditches cut thousands of acres of this fertile soil have been cleared and brought into cultivation, and many settlers have been attracted to it from outside the State. Much information is needed, therefore, on the methods of handling these muck soils for best crop results, and the work on the station is planned with the view of working out a practical solution of some of the fundamental problems confronting the farmers of this section.

Drainage.—The drainage investigations have proven the value of tile drainage for these muck soils. This was doubtful at the beginning of the test for two reasons: one, that with the extremely flat grade required in laying such tile it would tend to fill up because of muck seeping through; the other, that as this black soil settles the tile lines would sag out of grade and thus ruin the drainage. However, 3.6 miles of tile are now in use on the station farm, and it works perfectly. Some of the lines have been in use for eight years. The size of tile ranges from four to fifteen inches and is laid at a minimum depth of four feet. The grade used varies from one-half to one inch per hundred feet. The lines are spaced 330 feet apart, this being the standard spacing for all open ditches in this section.

Agronomy.—Corn has been the only money crop so far tried that succeeds well the first year after clearing, but the practice of continuous cropping with corn, even though lime has been applied, tends to decrease the original yield. More information is needed on the value of fertilizers and crops than can be grown in rotation with corn. With this view, a three-year fertilizer rotation test was started on the station last year: the first year, corn; the second year, spring oats followed by soybeans for seed or hay; third year, Irish potatoes followed by soybeans for seed or hay. Considerable information was gained in the first year test, the oats and soybeans making a very favorable showing.

The lime tests conducted prove that lime is essential to the production of corn and soybeans, and that finely ground limestone is better than marl or hydrated lime.

The fertilizer experiments indicate that stable manure, nitrate of soda and kainit, applied separately or in combination, will increase the yield of corn. Acid phosphate seems to have very little, if any, value when used alone or in combination with other materials.

The experiments with truck crops, cultural practices, hay crops, pasture mixtures and seed improvement were continued during the year with favorable results.

Swine Investigations.—The hog work at this station probably attracts more attention than any other phase of the experimental work now being conducted. The feeding experiments last year proved that with corn at 65c. per bushel, we could “drive it” to market and receive \$1.10 per bushel. The test also proved that fish meal and shelled corn were better than tankage and shelled corn from the standpoint of gain and cost. The cost per hundred-pound gain with the fish meal lot was \$5.14 against \$5.83 per hundred pound gain with the tankage lot.

This year soybean meal will be tested against fish meal as to its feeding value, and tests to determine the best grazing crops for swine are under way and will be reported on in the next report.

The general crop land is planted to hay, oats and corn with the view of producing sufficient feed for the work stock and supplying corn for the extensive hog feeding experiments. Under the present plan two car-loads of hogs from the feeding tests will be marketed each year.

Improvements.—The following items of improvements have been undertaken during the year, which will facilitate the economic management of the station as a whole, and greatly add to general appearance: new engine and pump house, additional room, porch and bath-room on tenant house No. 1; completed septic tank, 500 feet of water line to all hog lots, fenced in four acres additional hog lots, painted horse barn, corn crib, seven hog farrowing houses, new five-room tenant house, water tank and engine house; new system of fences around poultry lots, and tenant houses and new hog feeding house under construction. Purchased two-row corn planter, grain drill, two-row cultivator and lime sower.

COASTAL PLAIN EXPERIMENT STATION, WILLARD

It is the purpose of this report to emphasize new undertakings, station improvements, and notable results, rather than to detail the progress on well established projects of the station as such subjects will be covered under reports of the different subject-matter divisions.

Improvements made during the year have materially benefited the station and added to its efficiency. The implement shed begun in 1922, was completed and put into use, and has in addition to anticipated use, enabled a better handling of the annual picnic crowds and the storage of surplus hay, that would otherwise have been stacked in the open. New fences were placed about the dairy, and additional fencing is under way around the calf lots and pasture. A new building was added to the dairy group which furnishes the much needed bull pens and maturity stalls. Some minor improvements in the dairy barn proper were also made to permit the daily removal of manure from the barn to the fields in manure spreader without other handling. Last winter a field (which has been named the “Scott Field” in honor of the member of the board championing the work) was taken in as farming land. This required

tile drainage, as well as clearing. The result was that this land heretofore idle, yielded thirty bushels of corn per acre and a crop of soybeans and fodder to turn under this winter. The work of clearing and establishing the twenty-six-acre permanent pasture was completed during the year. A collection of fifteen varieties of Japanese persimmons, six varieties of figs and three varieties of native plums were added to the orchard plantings.

New Undertakings.—The station has undertaken a project of growing narcissus bulbs. The government embargo on these bulbs becomes effective in 1926, thus shutting off an importation of 77,000,000 bulbs annually. It is believed that no section of the country is better adapted to the production of narcissus, and the station is attempting to lead the way, and at the same time gain experience which will permit it to advise others who take up this industry. The station has purchased approximately 65,000 bulbs. These are being planted, and the flowers will be sold annually to help defray maintenance costs. In 1926 mother bulbs will be sold under a contract now made, and there will be left an accumulation of smaller bulbs that will permit a sale of mother bulbs annually thereafter.

In cooperation with the Agronomy Division, a pasture experiment consisting of ten different experimental plantings has been made; also a seed breeding project has been started during the year for the improvement of Norfolk Early Market Corn, a leading truck crop of the section, and Cocker's Prolific corn, the variety of field corn recommended for this section.

In addition to improvements before mentioned for the dairy project, the station has purchased a four months old bull calf whose pedigree includes the only two gold medal Jersey bulls, south of the Mason and Dixon line.

Three acres of strawberries, a leading money crop of the section, have been interplanted with the muscadine utilization vineyard that begins bearing next year. This demonstration of "two-story horticulture" has already attracted considerable attention.

Notable Results.—The station had developed its dairy to the extent that it was possible last spring to transfer a herd of twenty animals to the Mountain Branch Experiment Station for the purpose of starting an experimental dairy there.

The station sold a cow from its experimental dairy at the State Jersey Breeders Association for \$450, just \$50 less than the gold medal cow which topped the sale.

The fertilizer tests of the Agronomy Division have yielded much data on rotations and fertilizer, which is generally used by the farmers of the section. The soybean seed selection work has progressed to the point of supplying seed of the better varieties to the local farmers at a reasonable price.

The anthracnose project of the Botany Division indicates that the disease is spread by the boll weevil.

In the herd development work the first group of heifers matured shows an increase milk production of approximately two pounds per year over that of their dams. These daughters were sired by Eminent 19th, No. 78620, and have been bred to Rumina's King, No. 160969. Only a few of the second group of heifers are in milk. One is on test now and is expected to qualify for a silver medal.

The tests with peanut meal as contrasted with cottonseed meal for maturing heifers, show that both feeds appear to grow the animals satisfactorily when mixed with equal parts of crushed corn, oats and wheat bran.

In determining the value of home mixed and ready mixed feeds for milk production, the results show home mixed feeds are in a large majority of instances more palatable, produce more milk and cost considerable less per ton.

In the poultry marketing experiments, simple rations as equal parts corn meal and ground oats with milk, give as good results as the more complex and expensive mixtures.

Several new varieties of Muscadine grapes have been developed in the grape breeding experiments which are very promising, and additional information has been secured on the methods of pruning and training, also the grape utilization work.

The station made a general exhibit at the Southeastern Fair, the main feature being an object lesson in animal feeding. Proper rations were graphically illustrated. Other exhibits of educational nature were made at the State Fair and Castle Hayne Fair.

The annual farmers field day and picnic of the station proved a great event and a means of bringing the station into closer contact with the farmers of the section. About 3,000 people attended the picnic in automobiles, and train, buggies and carts brought their quota. A program of appropriate instruction was prepared featuring specialists of the Experiment Station staff, followed by inspection trips over the experimental fields.

UPPER COASTAL PLAIN EXPERIMENT STATION, ROCKY MOUNT

The program for work on this station deals with the fundamental problems confronting the farmers of the upper coastal plain region. At present boll-weevil control, soil fertility, seed improvement, swine feeding tests, cropping systems and horticultural investigations have been deemed most important and the experiments now under way are carefully planned with the view of supplying new information to the farmers of the section.

Agronomy.—Field D—The agronomy rotation experiment has been continued another year, and interesting data have been secured on the

importance of well-planned rotations against continuous cropping with corn and cotton. This test has been running several years, and will soon be ready for publication.

This past spring a new series of fertilizer experiments were started to determine the effect of different formulas and applications on the maturity and yield of cotton under boll weevil conditions. The results for this year showed considerable difference at first picking in favor of high or reasonably high percentage of acid phosphates, and that a heavier application of fertilizer than generally used is profitable. The cotton breeding work is confined to the Mexican Big Boll variety. The strain developed here is meeting with much favor over the cotton growing area of the State, especially in the Coastal Plain region and Eastern Piedmont on account of its uniformity, yield and length of staple. In the plant-to-row tests this year many rows showed unusual production and gave a staple of $1\frac{1}{8}$ inches.

The station planted thirty-five acres of cotton this year, using the selected seed from last year's crop, and will make close to forty 500-pound bales. The seed from this cotton has been engaged in advance for planting purposes. Last winter 1,200 bushels of pure-bred seed was distributed over the State from the 1922 crop, and all reports from the parties using this seed were very favorable.

This year breeding work has been started with Latham's Double corn and Fulghum oats.

This work of producing improved strains of seed of the better varieties for the section and distributing them at a fair price to near-by farmers is proving a great factor in agricultural uplift.

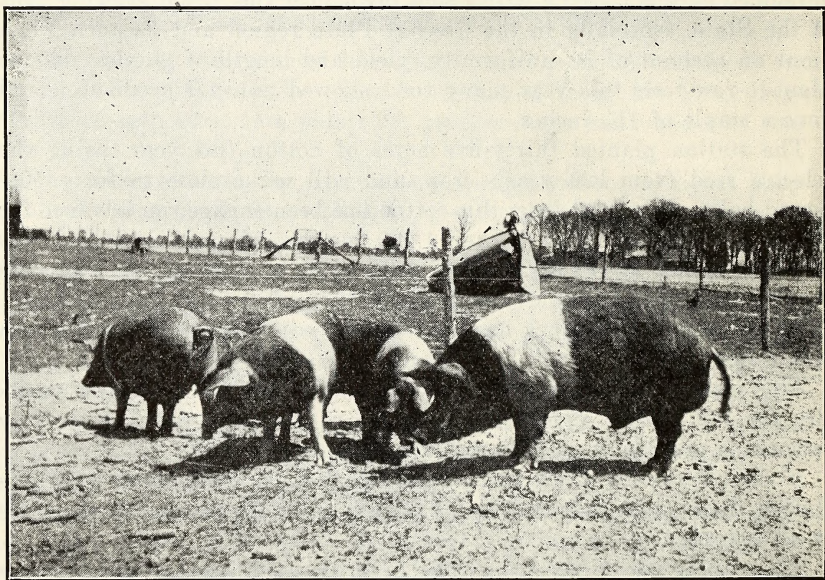
Horticulture.—A year-round farm garden is demonstrated on the station showing the possibilities of having fresh vegetables for the table at all seasons.

The variety pecan orchard yielded a short crop this year owing to the late spring frost, but the results were favorable in further proving the better varieties for the Upper Coastal Plain region, namely, Schley, Stuart, Alley and Success.

The sweet potato seed selection and improvement work showed good results, and 200 bushels of improved Porto Rico and Nancy Hall seed potatoes were distributed to growers in eastern North Carolina. With the new modern sweet potato storage house completed last year, storage tests were conducted to determine the best method of storing sweet potatoes, also the storage qualities of different commercial varieties.

Swine Investigations.—With the pure bred herd of Hampshire hogs and the new equipment added last year, the feeding tests this year have furnished considerable information. The primary object of the hog work is to determine the best method and cost of carrying a pure bred herd under average farm conditions. This is to include the value of different feeds, pasture crops and utilizing all the so-called waste from

the farm. The experiments under way are: To determine the value of a combination of peanuts and sweet potatoes and the effect on body carcass; to determine the value of sweet potatoes when fed to hogs; to determine the value of hogging off corn and soybeans grown together and the effect on the body carcass; to determine the cost of raising pigs to weaning age under various conditions and seasons; to determine the practicability of gleaning soybeans and peanut fields with pigs in pork production, and to determine the adaptability of breeds of swine to various conditions in the State.



A typical purebred Hampshire herd at the Upper Coastal Plain Station, used in connection with the swine investigational work.

The data from the sweet potato feeding test were especially noticeable. Cull sweet potatoes of little if any market value, were used in the first test. The results show that with corn at \$1 per bushel and fish meal at \$60 per ton, the cull sweet potatoes were worth 34c. per bushel when fed alone, and 25c. per bushel when fed with 2 per cent of corn. The pigs were sold at a premium on the local market because of their excellent quality.

In the second sweet potato test the pigs were turned into the field and allowed to harvest the crop. They also had access to a self-feeder containing fish meal and mineral mixture. Because of dry weather the yield of sweet potatoes was rather low, since the average area harvested yielded only 105 bushels per acre. But despite this low yield of pota-

toes, 360 pounds of pork per acre was produced. This as a greater return than that from other crops of comparable yields, and in addition the pigs handled in this way "killed out hard."

Improvements added during the year have facilitated the handling of experimental and general crop work, and have increased the efficiency of the station as a whole.

A new modern central hog house has been constructed to take care of the sows at farrowing time, and to provide space for individual dry lot feeding tests.

A new system of fencing has been installed for the hog pasture lots with water connection in each lot.

The four tenant houses have been repaired and are now in good condition, which will enable the farm to hold good labor.

Two acres of waste lands have been cleared and are now in grazing crops for the hogs.

A new fence has been built around the seven and one-half acre pecan orchard, which adds a great deal to the appearance and provides additional hog pasture.

The drainage system on the back side of the farm has been improved, thereby bringing into cultivation several acres of land which heretofore have been idle.

The general farm work is planned as near as possible to produce feed for the farm work stock, and the hog feeding experiments, and to produce such money crops as may seem advisable.

While the experimental work is given first consideration, it is important that our general farm work should be above the average, and should serve as an example of good farm practices for the upper coastal plain region. The station is having more calls for information than ever before, as the boll weevil has about convinced the farmers that it will be necessary to do better farming than they have been doing.

The first annual field day was held last August with very gratifying results, and it was voted to make this an annual big farmers day for the section.

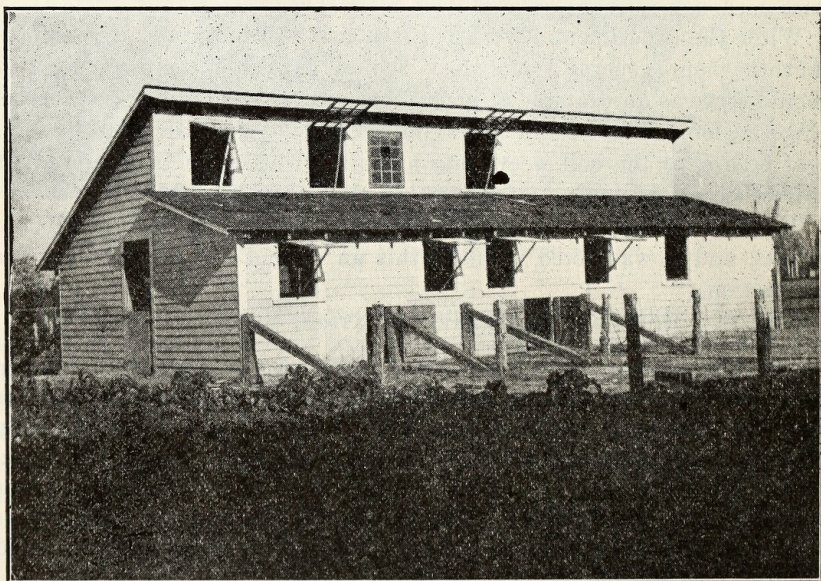
MOUNTAIN EXPERIMENT STATION, SWANNANOA

The mountain section of the State embraces the large high plateau area extending from the Tennessee line eastward, including the irregular chain of mountains known as the Blue Ridge. The average elevation of these mountains is around 4,000 feet, although the highest peak, Mount Mitchell, is 6,711 feet above sea level. The foothills and river valleys range from 2,000 to 3,000 feet in altitude, and the soils of this area are very fertile. The mountain sides, in many cases, are cultivated profitably up to their summits.

The Mountain Station is located in the Swannanoa River Valley on a hard-surfaced road between Asheville and Black Mountain, with an



Residence of Assistant Director in charge of the Upper Coastal Plain Station,
near Rocky Mount, N. C.



Central hog house at the Upper Coastal Plain Station, provides pens for the sows at
farrowing time, also pens for individual feeding tests.

altitude of 2,600 feet. The mean annual temperature is 55.4 degrees, and the annual precipitation 57.04 inches. The station consists of 305 acres, which represent the typical soils of the region. This section has great agricultural possibilities, principally with fruit, truck crops, dairying, poultry and pasture crops, and the work on the experimental farm is planned with the view of developing these industries.

The work on the station has grown a great deal in the past two years, and many improvements in the way of buildings and equipment have been made. The two major projects added to the work are poultry and dairy investigations, and modern equipment has been provided to take care of these important projects. The horticultural work has been enlarged, and two additional acres were planted with apples to further provide for the fertilizer and pruning experiments.

Agronomy.—The fertilizer and rotation tests were carried forward another year, and the results have furnished valuable information for general farming in the section.

Field A—Soil fertility and rotation studies with corn, wheat and red clover. The results indicate that phosphoric acid, nitrogen and lime are needed to produce large yields, and that phosphoric acid is the foremost plant food requirement.

Field B—Rotation and soil type tests showing the effect of continuous cropping in comparison with well planned two and three-year rotations where legumes are used.

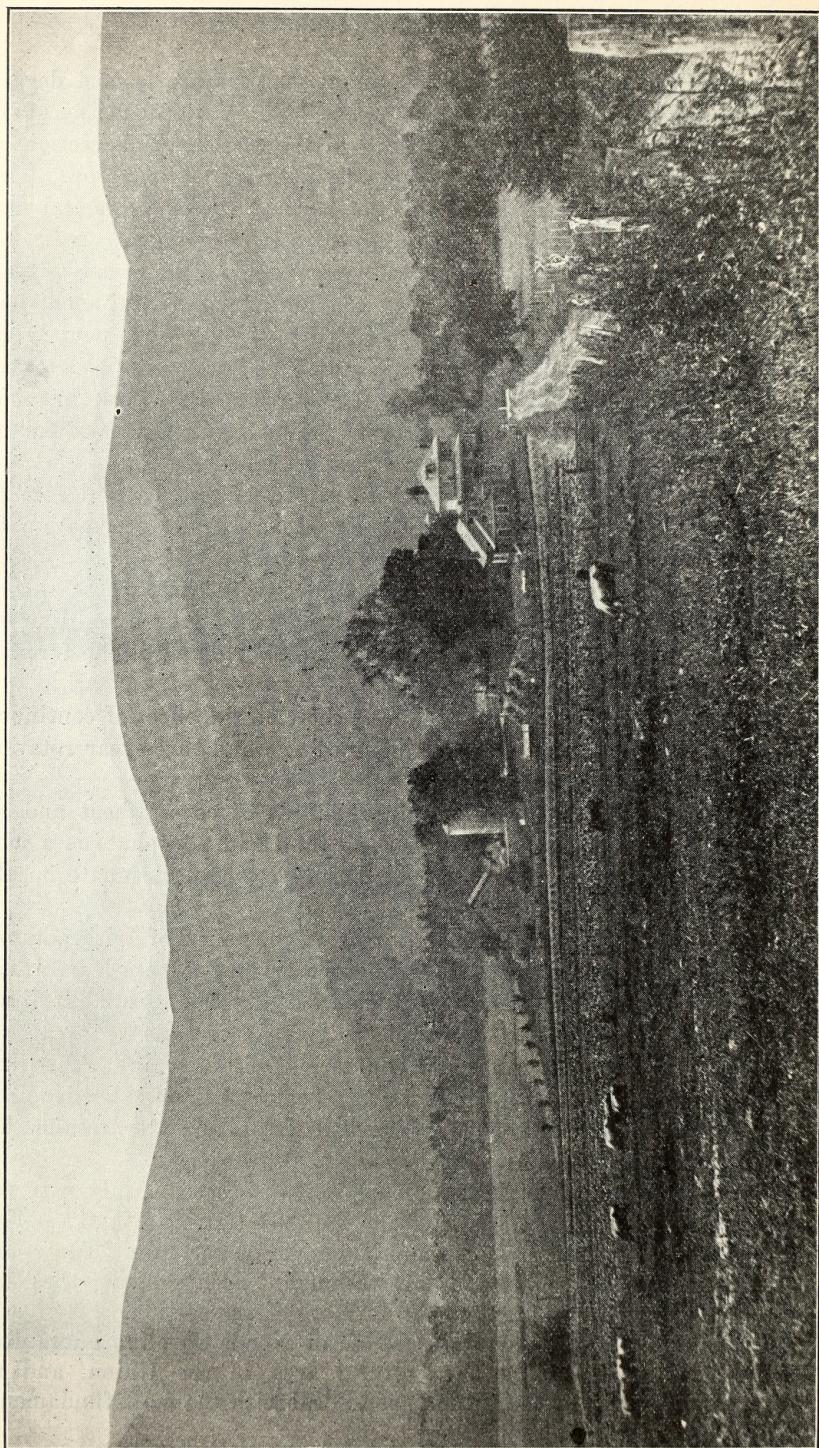
Field D—Rock phosphate test in rotations of corn, wheat and red clover. The results so far secured show that acid phosphate is a more economical carrier of phosphoric acid than is rock phosphate on this soil.

Field F—Special potash test in a rotation consisting of Irish potatoes, corn, wheat and red clover. The different sources of potash used have not materially affected the yield of potatoes, and the normal fertilizer used of 800 pounds of an 8-4-6 seems to give best results.

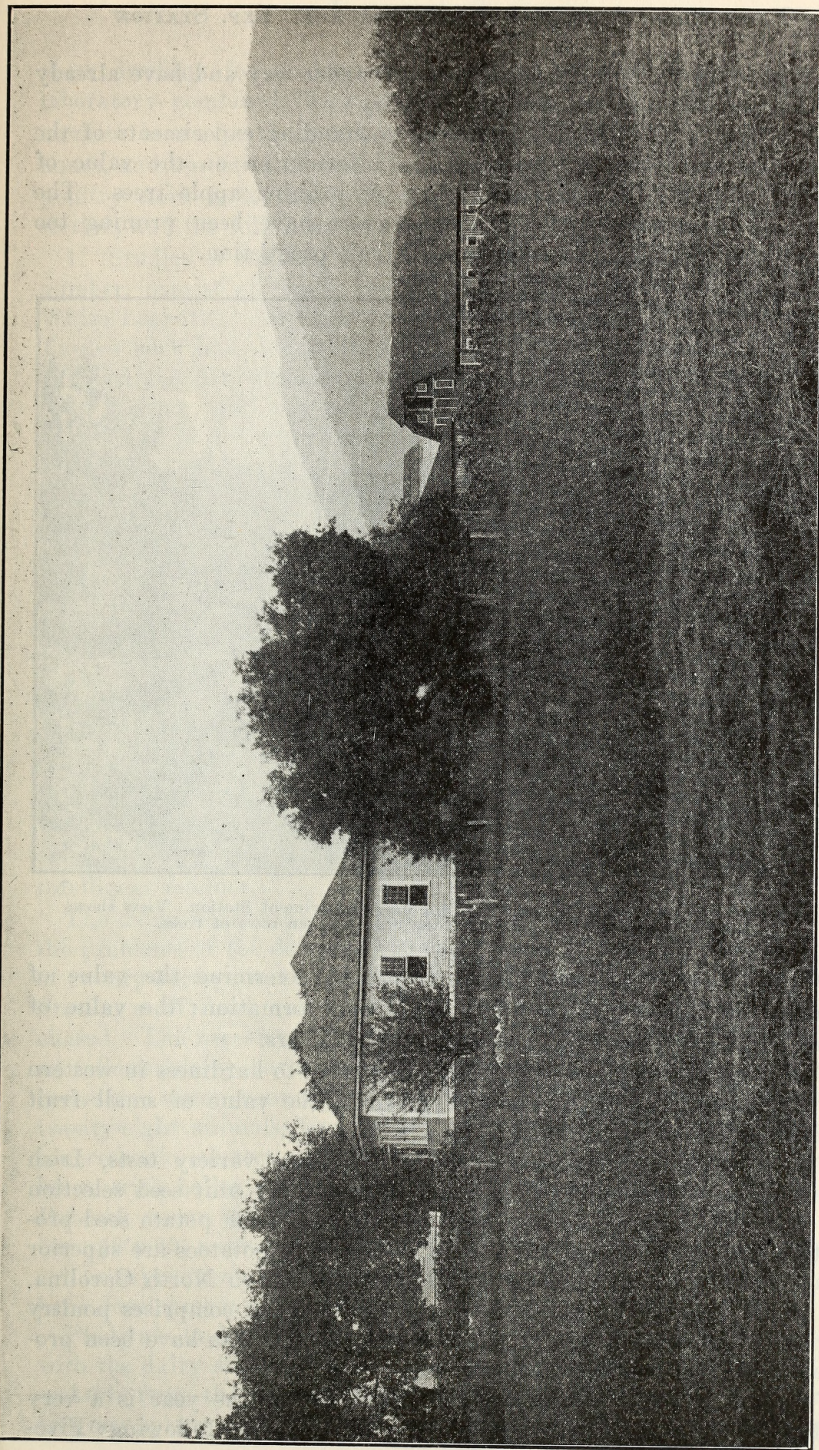
Field G—To compare phosphoric materials with a complete fertilizer, with limestone and with stable manure. The results indicate that finely ground limestone and manure with fertilizers give better results than where fertilizer is used alone.

The seed selection and improvement work has been mainly with soybeans, Haberlandt No. 38, and Biggs field corn strain No. 17. Tests are also conducted with wheat, oats and soybean varieties. The results have been very favorable, and the station has been growing these improved seed for distribution to the farmers of the section.

Horticulture.—This mountain section of North Carolina offers great possibilities as a leading horticultural area in the Union, and the projects under way at the station are to deal with the most fundamental



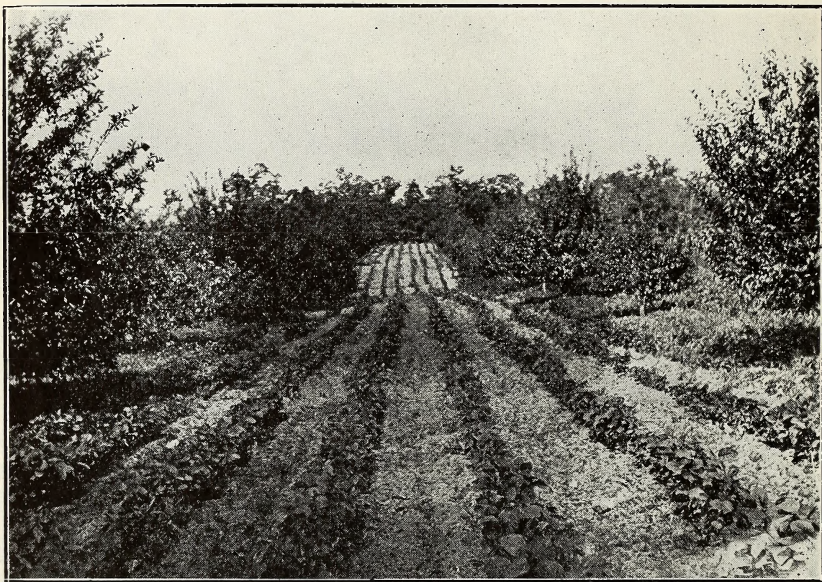
View of the Mountain Experiment Station located near Swannanoa on the hard-surfaced road which runs from Asheville to Black Mountain.



Office building and barns, with hay field in the foreground. Mountain Experiment Station.

problems. The following experiments are under way and have already furnished much information to the industry:

Apple Pruning.—This is one of the outstanding experiments of the station, and will furnish much needed information on the value of different systems and different amounts of pruning apple trees. The results so far secured indicate that growers have been pruning too severely, thereby causing a reduction in fruit production.



One of the experimental orchards at the Mountain Experiment Station. View shows soybeans planted as a soil-improving crop between rows of trees.

Other tests are conducted with apples to determine the value of thinning on the size of fruit and fruit bud formation; the value of different varieties, cultural methods and fertilizers.

The work with peaches deals with varieties as to hardiness in western North Carolina. Attention is also given to the value of small fruit varieties and cultural methods.

The truck crop investigations include cabbage variety tests, Irish potato seed production, Irish potato hill and tuber unit seed selection and vegetable garden studies. The results of the Irish potato seed production indicate that western North Carolina seed potatoes are superior to northern grown seed for the spring crop in eastern North Carolina.

Animal Industry.—This work on the station farm comprises poultry and dairy investigations, and thoroughly modern plants have been provided to handle each department.

The poultry plant which was completed during the year is a very creditable addition to the station, and consists of the following: Five-

room dwelling for poultryman, incubator house with feed room and laboratory combined, four 16'x24' brooder houses, one 20'x50' half monitor house for the breeding flock, one 20'x100' half monitor laying house, and ten acres of land fenced into poultry lots for grazing. The poultry work is to deal with the problems peculiar to the mountain section, and the following experiments are under way:

1. "Studies in building up a farm flock." The breeding flocks, two in number, consist of single comb Rhode Island Reds and single comb White Leghorns. The two flocks contain 150 hens each with 12 cocks. Twelve hens laid during the past year between two hundred and two hundred and fifty-eight eggs each, several of which were State records.

2. Feeding tests are being conducted to determine the kinds and amounts of feed for the breeding flocks.

3. The range experiments are to determine the methods of handling and the suitability of different pasture crops for chickens in the mountain section of the State.

4. One unit of 500 single-comb White Leghorns are maintained as an experimental commercial unit.

5. Incubation experiments in connection with the two breeding flocks are carried on in view of developing high producing flocks.

6. Studies in determining the cost of putting birds into the laying house by November 1st are under way.

7. Fattening tests are being conducted to determine the value of milk feeding young chickens before marketing.

8. Studies are made in the cost of marketing eggs and poultry.

The poultry work for the year gave very satisfactory results and indicates that it is a profitable industry for the section, if handled in an intelligent manner.

The dairy work was started in the spring of 1923, and is to deal with the problems of the dairyman in the western part of the State. A herd of twenty Jerseys was transferred to this station from the Coastal Plain Station at Willard, and a herd bull of Eminent breeding has been purchased. The necessary equipment has been added to handle the project as follows: dairy barn complete with concrete floor and mangers, the necessary water connections and drains, stanchions to accommodate twenty-eight animals, feed room and milk room, and one hundred-ton concrete silo connecting with the feed alley; a thoroughly modern milk house with boiler room, washing room and milk room equipped with Babcock tester, cream separator, milk cooler and sterilizer, and calf barn 18'x 60' with two bull pens combined and loft above for storage.

The experimental work at present deals with feeding and pasture tests, herd development and management and marketing dairy products.

Plans are under way to build a small cheese laboratory in connection with the dairy and to conduct experiments in making Swiss cheese.

Aside from the improvements in dairy and poultry plants, an attractive new spring house has been built of native rock combining engine and

pump room, milk cooling room and a section given over to the spring. A new garage also has been constructed to house the station automobile, truck and tractor.

The general farm land is handled in a way to demonstrate good farming methods for the section, to produce feed for the work stock, dairy and poultry, and to produce such money crops as may seem advisable.

The rapid development of the station has attracted many visitors seeking information on the various phases of agriculture. The station is a gathering place for those interested in agriculture, and the fertilizer manufacturers, principals of rural schools with their agricultural classes; county agents with groups of farmers, and many others visit the station during the year and study the different experiments under way. The third Thursday in August is set aside for the big annual field day and picnic. This has proved to be a very popular event, and has been helpful in getting the work before the farmers throughout the mountain section. An instructive program is prepared, which is followed by inspection trips to the fields. Here the different experiments are explained by the specialist in such a way that the farmer may take home the results and apply them to his own conditions.

PIEDMONT EXPERIMENT STATION, STATESVILLE

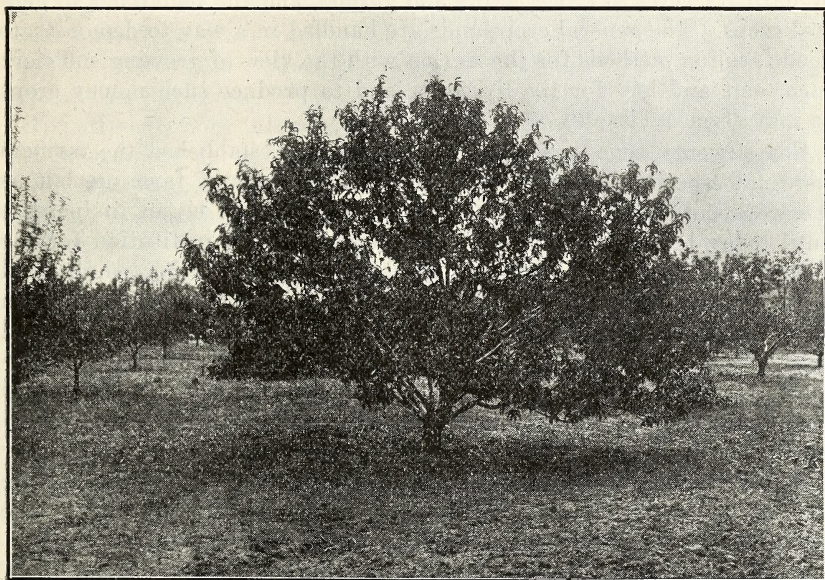
The Piedmont region comprises nearly one-half of the territory of the State, and the soils and climate are suited to a wide range of agricultural pursuits. The station farm is located pretty well in the center of this area, and the conditions here are typical of the Piedmont section. The important farm problems for the region are dealt with on the station farm, and much definite information has already been obtained on the better farm practices which is being generally used in the section.

Agronomy.—The agronomy experiments are more extensive here than at any one station in the State. The tests include three series of soil fertility and rotation tests with cotton, corn, wheat and red clover. Field D brings out the value of well-planned rotations in comparison with continuous cropping. Field E soil type studies. Field F nitrogenous materials for corn and cotton. Field G rock phosphate tests, and Field K tests with soft phosphates.

The November Bulletin of the Department of Agriculture published on Fertilizer Experiments with Wheat on Piedmont Red Clay Soils and Wheat Culture in North Carolina is a report on the results of the work with wheat on this station, 1911 to 1921, inclusive, and the information contained therein should be of great value to the Piedmont farmers. The seed selection and improvement work has been continued during the year with the following crops: Appler oats increase strain No. 11, Abruzzi rye increase strain No. 7, Virginia soybeans No. 11, Leaps Prolific wheat increase strain No. 32, King Cotton strain No. 29, Weekley's Improved Corn and variety studies with wheat, oats, rye, and barley.

The results of the breeding work have been very valuable and the station is now growing these improved strains and distributing them to farmers over the Piedmont section at a reasonable cost.

Horticulture work with small fruits, apples, peaches and pears is under way in determining varieties, methods of cultivation, intercropping, pruning, spraying and marketing; the results have been most instructive. A new four-acre experimental apple and peach orchard was planted last spring which includes some of the newer varieties for the Piedmont. Tests will be conducted with this orchard from the standpoint of fertilization, pruning and intercropping.



Peach tree in experimental orchard at Piedmont Station.

Livestock work here is confined mainly to hogs, sheep and feeding experiments with the work stock. The main sheep project is to determine the kind of pasture suited to sheep under Piedmont conditions, and some very striking results have been obtained both with summer and winter pastures. A flock of thirty ewes and one ram is maintained on the station for these studies, and information is secured on the cost of maintaining breeding ewes and producing lambs. A series of pastures have been arranged that will provide grazing practically the year round for the sheep-and hog-feeding tests.

The swine experiments show that it costs \$3.97 to raise pigs to the weaning age, and that the number of pigs in the litter has little effect upon the size of each pig at weaning time. Complete information on the methods and cost of raising pigs to the weaning age is given in a

recent bulletin prepared by the Animal Industry Division. Further tests are under way to determine the value of different grazing crops for swine. Seven purebred Poland China brood sows and a boar were used in these experiments.

Feeding tests with the farm work stock show that cottonseed meal is relished more by horses than mules, and that 1½ pounds can be fed daily to a work animal. When cottonseed meal is fed the grain ration is cheapened slightly.

General Crops.—The station farm consists of 210 acres of which 70 acres are devoted to experimental plats, 40 acres to pasture, 18 acres to orchard, 12 acres to grove, yards and garden, and the remainder to general crops. The general crop lands are handled in a way to demonstrate good farming methods for the section with the view of growing sufficient corn, oats and hay for the livestock, and to produce such money crops as may seem advisable.

Some twenty years ago when the station was established the farmers were not especially interested in improved methods of farming, but as the work on the station developed the local interest began to increase until today the station stands out as an agricultural institution for the Piedmont area. The popularity of this station is further emphasized by the attendance at the main farmers field day held last August, when about eight thousand people gathered here for the meeting. Several smaller meetings were also held for the purpose of recreation and studying the work of the farm. The county agents frequently bring groups of farmers from adjoining counties to study the results from the different experiments. These meetings are becoming more popular each year and are encouraged, as they are one of the best means of bringing the farmers in touch with the station and for getting the results of the station put into practice.

TOBACCO EXPERIMENT STATION, OXFORD

The tobacco experimental work at Oxford has been continued in co-operation with the U. S. Department of Agriculture and additional information on tobacco culture has been secured. The principal experiments under way are fertilizer tests, variety tests, rotation systems for tobacco, tobacco after cowpeas, permanent tobacco seed beds, potash and lime experiments, nutrition investigations with continuous cropping, legume effects, and general crop effects.

The results of the magnesium and potash plats were especially outstanding this year. Where fairly liberal applications of magnesia were applied, either from dolomitic limestone or double manure salts and kinit, no Sand Drown was prevalent with the exception of double manure salts plots where calcite was applied and where no lime was used. On these two plats a small percentage of the plants developed symptoms of Sand Drown, indicating that the amount of available magnesia was insufficient to mature the large growth of the leaf which prevailed this

season. The tobacco fertilizer plats further proved that cottonseed meal as an individual source of nitrogen stands highest with nitrate of soda, dried blood and ammonium sulphate next in the order named, although a mixed nitrogen composed of one-fourth of each of the above ingredients gave satisfactory results. Acid phosphate gave better results than any of the other sources of phosphate. Muriate of potash produced tobacco with a larger yield and higher market value than tobacco grown with high grade sulphate of potash, although all tests have shown that the tobacco produced with the sulphate of potash has a better burning quality than that produced with muriate of potash. The test with twenty-five so-called varieties was conducted and selections were made from each variety with object of improving the yield and quality. Some crosses were also made with the view of developing new outstanding varieties.

Experiments with tobacco after cowpeas have been fairly satisfactory, but in order to get best results from such cropping it is necessary to plant tobacco close, top high and harvest by priming. If this is not done an excessive amount of nitrogen will produce tobacco of poor quality.

Under the directions of this station, tobacco demonstration tests were conducted at Reidsville and Clarkton. These tests furnished first hand information to the tobacco growers of the respective localities.

In addition to the experimental work with tobacco, some work with seed corn breeding and selection has been conducted on this station under the direction of the Division of Agronomy at the College and Central Station. The results have been helpful in supplying good seed for the station use and some for distribution to farmers in the adjacent section.

Several meetings have been held at the station this year at which the experimental work was studied, the field results observed and followed by a discussion of the various phases of the work. On July 4th around three hundred farmers and business men attended a meeting at this station, at which members of the Board of Agriculture, President of the State College and the officials of the department discussed the object of the Experiment Station work and results obtained. The latter part of July, about thirty representatives of the fertilizer manufacturers with several fertilizer dealers, business men and farmers met at the station to discuss fertilizer problems for tobacco. Two county agents brought farmers to the station to study tobacco problems. In all, there has been a larger number of farmers, both locally and from other counties, to visit the station this year than heretofore. The local high schools have taken more interest in the work this year than previously.

In regard to improvements on the station, will state that some progress has been made in carrying out the landscape plans as submitted by Prof. Mulford of the U. S. Department of Agriculture last spring.

A new garage and poultry house have been built at a nominal cost. Most of the outbuildings have been painted. A big problem for the winter is clearing up and draining a field on the National Highway, which will take quite a considerable amount of time and labor. The drainage plans will be submitted by the Drainage Engineer for this project. When this work is completed as now planned it will add considerably to the general appearance of the farm, also to its productiveness.



The residence of E. G. Moss, who conducts the N. C. Tobacco Experiment Station near Oxford, N. C. This station has 250 acres devoted to a study of tobacco production.

The crops on the station as a whole have been fairly good this year. Plenty of feedstuffs have been made for the farm and some to spare. As a whole the work has progressed satisfactorily both as to experiments and general cropping.

INSECT AND DISEASE CONTROL

Control work with insects and plant diseases on all of the station farms are under the direction of the Divisions of Entomology and Plant Pathology. The spray calendar for each station is prepared by these divisions and the actual spraying or dusting is done under close supervision.

DIVISION REPORTS

Complete information as to the work of the various divisions of the Experiment Station are contained in the report of divisions, which follow the financial statement.

FINANCIAL REPORT

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,

In Account With the UNITED STATES APPROPRIATION, 1922-1923.

Dr.

Hatch Fund Adams Fund

To receipts from the Treasurer of the United States, as per appropriation for the fiscal year ended June 30, 1922, under Acts of Congress approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund)	\$15,000.00	\$15,000.00
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Cr.

Salaries	\$9,738.04	\$13,433.29
Labor	1,891.17	1,055.06
Postage and stationery.....	118.73	119.76
Freight and express.....	59.65	15.78
Heat, light, water, and power.....	86.30	94.30
Chemicals and laboratory supplies.....	228.13	25.95
Seeds, plants and sundry supplies.....	174.27
Fertilizers	658.42	140.98
Feeding stuffs	699.16
Scientific apparatus and specimens.....	26.91
Live stock	440.00
Traveling expenses	156.13	87.97
Buildings and land.....	750.00
	\$15,000.00	\$15,000.00

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,

In Account with FARM AND MISCELLANEOUS RECEIPTS.

Dr.

Receipts from other sources than the United States for the year end- ing June 30, 1923.....	\$7,098.65
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SUPPLEMENTAL STATEMENT

Cr.

Labor	\$133.55
Postage and stationery.....	5.00
Seeds, plants and sundry supplies.....	153.03
Fertilizers	32.22
Feeding stuffs	31.17
Library	157.90
Tools, machinery, and appliances.....	363.48
Furniture and fixtures.....	77.00
Scientific apparatus and specimens.....	115.41
Traveling expenses	36.62
Contingent expenses	4,444.94
Buildings and land.....	51.16
Balance	1,497.17
Total.....	\$7,098.65

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the North Carolina Agricultural Experiment Station for the fiscal year ended June 30, 1923; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was nothing from the Hatch and Adams Funds; that the receipts for the year from the Treasurer of the United States are shown to have been \$30,000, and the corresponding disbursements \$30,000, for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving nothing.

And we further certify that the expenditures have been solely for the purposes set forth in the Acts of Congress, approved March 2, 1887, and March 16, 1906.

(Signed) P. C. BIRMINGHAM COMPANY, *Auditors.*

By P. C. Birmingham, C. P. A.

(SEAL)

Attest: A. F. BOWEN, *Custodian.*



We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the North Carolina Agricultural Experiment Station for the fiscal year ended June 30, 1923; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was nothing from the Hatch and Adams Funds; that the receipts for the year from the Treasurer of the United States are shown to have been \$30,000, and the corresponding disbursements \$30,000, for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving nothing.

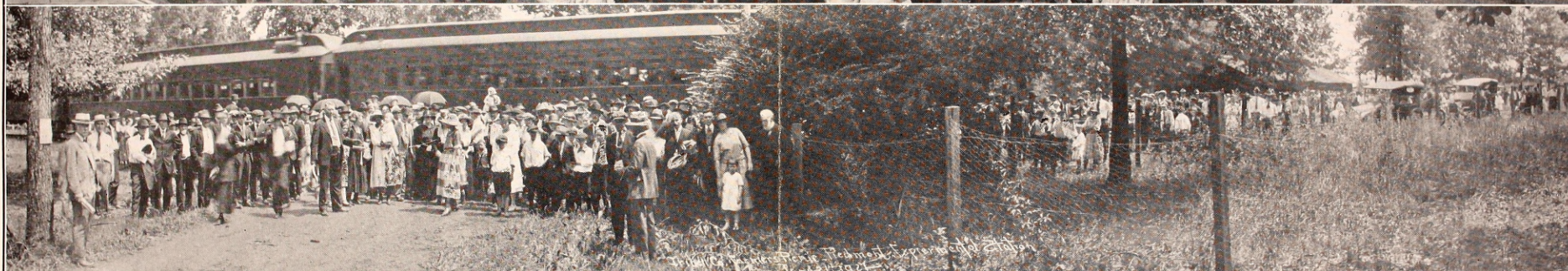
And we further certify that the expenditures have been solely for the purposes set forth in the Acts of Congress, approved March 2, 1887, and March 16, 1906.

(Signed) P. C. BIRMINGHAM COMPANY, *Auditors.*

(SEAL)

By P. C. Birmingham, C. P. A.

Attest: A. F. BOWEN, *Custodian.*



Upper—Mountain folks at annual picnic, Mountain Branch Station, Swannanoa, N. C.
 Center—Farm folks at Piedmont Station Farm. The Southern Railway runs through the grounds.
 Lower—Governor Cameron Morrison speaking to North Carolina farm folks at Coastal Plain Station. Part of a 5,000 crowd of farmers.

REPORT OF THE DIVISION OF AGRONOMY

To the Director:

The work of the Division of Agronomy during the year has been conducted largely along lines mentioned in previous reports. It is felt that the experimental work is organized and is being pushed in a safe and conservative way. In the field experiments a great amount of information is being secured and supplied to farmers with reference to the best ways of handling the different problems connected with the most economic management of their soils, and production of the crops they are growing.

The work has been mainly carried on along the lines mentioned below, with the results indicated:

SOIL SURVEY

During the year the soil survey work, in coöperation with the Federal Bureau of Soils, has been actively continued. Since the last report surveys have been finished and reports prepared of Sampson, Currituck, Camden, and Polk, and work started in Rutherford, Greene, Wilson and Northampton counties. The maps and reports prepared in these surveys are not only of the most fundamental importance to our agricultural investigations, but they have been of the greatest value to farmers, county agents, extension workers, surveyors, settlers, lumbermen, rural teachers, land appraisers, business men, community workers, and others who wish definite information with reference to the soils, agriculture, roads and geography of the counties. There has been a steadily growing demand and appreciation on the part of the people of the State of the value of this fundamental work in the various counties. Up to this time surveys and reports have been prepared of fifty-eight of the hundred counties of the State. Two parties of two men each, and part of the time three parties, have been at work in the State continuously. Of the workers, the Federal Bureau of Soils has had two to three of its own men with two State men working throughout the year.

STRENGTH AND WEAKNESSES OF SOILS

In every soil there are generally two kinds of plant food, potential and active or available. The potential is the reserve plant food that the plant may draw upon in the future, provided proper methods of handling the soil are put into operation. The active or available plant food is that which is soluble in the soil water, and is in a form that plants can take up in their growth during a normal growing season.

It does not necessarily follow, however, although it is usually the case, that because a soil shows marked and paying results from the use of any plant-food constituent, for instance phosphoric acid, that the soil is low in total quantity of this constituent. The same condition would apply to nitrogen and potash. It might be that the soil might be well

supplied with a plant-food constituent, but that this particular one was held or locked up in such an insoluble form in the soil that crops could not for the time secure it for their growth. On the other hand, we might have a soil that did not show a certain constituent, say phosphoric acid, which is greatly needed to be applied at the present time to secure goodly yields, yet the analyses of the soil might show that the particular soil was very low in content of phosphoric acid, and hence is in need of additions of phosphoric acid in available form. In those two cases, the problems of handling the two classes of soils are entirely different. One is largely a problem of making available the plant-food reserves of the soil, while the other is that of supplying the needed plant-food or foods at the present, or in a short time, because of the too low reserve of it or them in the soil for goodly yields of crops.

How North Carolina Soils Stand in Plant Food.—Below is given a table showing the plant food reserves of prominent North Carolina soil types as brought out by the chemical analyses and by the number of corn crops, for instance, required to remove the different kinds of plant foods contained in the different soils. The total plant food reserves are as follows:

Average Composition of Main Types of Soil of North Carolina

TYPE	Pounds Plant Food in Surface 6½ Inches			Number 50-Bushels Corn Crops When Removed Required to Exhaust Different Constituents of the Soil		
	(N) Nitrogen	Phos- phoric Acid (P ₂ O ₅)	Potash (K ₂ O)	(N) Nitrogen	Phos- phoric Acid (P ₂ O ₅)	Potash (K ₂ O)
IN COASTAL PLAIN:						
Norfolk Sandy Loam.....	603	432	5940	8.0	16.0	140.0
Norfolk Fine Sandy Loam.....	819	654	5340	11.0	25.0	126.0
Norfolk Fine Sand.....	665	674	5232	9.0	25.0	123.0
Norfolk Sand.....	759	857	11038	10.0	32.0	260.0
Portsmouth Fine Sandy Loam.....	1400	481	9565	19.0	18.0	225.0
Portsmouth Sandy Loam.....	2140	463	7140	29.0	18.0	168.0
Portsmouth Fine Sand.....	3874	417	5198	52.0	16.0	122.0
Coxville Fine Sandy Loam.....	1360	600	1740	18.0	23.0	41.0
Muck.....	3704	1735	8019	50.0	66.0	189.0
IN PIEDMONT REGION:						
Cecil Sandy Loam.....	801	571	49260	11.0	22.0	1159.0
Cecil Clay Loam.....	1179	819	8183	16.0	31.0	193.0
Cecil Clay.....	1285	1450	17743	17.0	55.0	418.0
Iredell Loam.....	903	2840	4849	12.0	107.0	114.0
Mecklenburg Clay.....	1307	2851	10118	18.0	108.0	238.0
Granville Sandy Loam.....	614	654	16275	8.0	25.0	383.0
Durham Sandy Loam.....	434	302	6337	6.0	11.0	149.0
IN MOUNTAIN REGION:						
Toxaway Loam.....	3160	3320	33600	43.0	125.0	791.0
Porter's Sandy Loam.....	2394	1152	64853	32.0	44.0	1526.0
Porter's Loam.....	2010	2330	38285	27.0	88.0	901.0
Porter's Clay.....	1454	860	12416	20.0	33.0	292.0

It will be noticed from the above data obtained in our soil work that the predominant typical soils of the Coastal Plain and Piedmont regions of the State are much more poorly supplied, generally, with nitrogen, phosphoric acid and potash, especially nitrogen and phosphoric acid, than are the typical cultivatable mountain soils.

Coastal Plain Soils.—The main deficiencies, as shown by analyses, of most of the soils in the Coastal Plain section are phosphoric acid, nitrogen, with potash coming third. Field results have shown that although the potash in soils of this section is contained generally in fairly large amounts, it evidently is not in as readily available form, as shown by the responses from its use, especially on the coarser sandy soils, as in the soils of the upper section of the State. The phosphoric acid, although small in quantity, is contained in quite an available form, and for this reason field results have shown this constituent to be less important and potash more important than chemical analyses of the soil would seem to indicate. In a general way, most of the soils of this section of the State, however, may be said to be too low in phosphoric acid and nitrogen, except those well supplied with organic matter like the mucks and some of the soils of the Portsmouth series, for the most profitable growth of such crops as cotton and tobacco.

Piedmont Soils.—The prevailing types of soil in this section of the State, as shown by the analyses in the table, as well as by continued field experiments, are deficient mainly in nitrogen and phosphoric acid, except the Iredell loam and Mecklenburg clay loam soils, which are fairly high in content of phosphoric acid, and have been shown by field experiments to not return usually profitable results from the use of materials carrying this constituent in available form. Potash used on these latter soils has usually shown up profitably for general crops like cotton. This latter constituent has not generally been found so highly essential with most general crops grown on the other more important and extensive types of soil of the Piedmont section of the State, especially when they are handled properly.

Mountain Soils.—As will be seen from the analyses, many of the soils of this section are generally potentially fairly well supplied with plant-food, especially potash. Continued field results with different crops, however, have shown that phosphoric acid, generally, is essential with most of the soils of the mountains for best paying results. Some of the bottom lands (Toxaway) have shown that the use of potash in available form has given paying results, especially so when this constituent is selling at anything like normal prices. Nitrogen with the upland soils low in organic matter, as well as with many of the bottom lands of the mountain section, is necessary to be applied in commercial forms for best paying returns, with most crops with a high selling price.

With soils of all sections of the State, when handled properly with the growth of suitable leguminous crops in rotation with the main money

crops, and the turning into the soil of all or part of these, it becomes necessary to use lime in most cases in order to secure best results in their improvement.

TWO IMPORTANT FACTORS THAT ENTER INTO A PROFITABLE AGRICULTURE

No thoughtful person can fail to realize that to a very large extent the prosperity of North Carolina farmers is closely associated with the productiveness of their soils. Go wherever you may, if the farmer is doing his part intelligently for his soil and its productiveness, you will find that he is generally making some money and is maintaining much better standards of living than is ordinarily being maintained. So, at the very foundation of the prosperity of our people lies the question of soil fertility and the use of crops and varieties of crops that will give the largest returns for the expense and effort put into the production.

Where people are dependent solely upon the farm for a livelihood they can never be very prosperous as a general thing unless the soils are reasonably productive. Nations in the past have fallen, because to a considerable extent their soils failed to give remunerative returns to those engaged in farming. Any thoughtful person may, therefore, see that information that will be helpful to our people in building up the economic production of their soils and in the growing of crops that are going to give them the largest yields per unit of labor and expense, is going to be in the interest of public good.

There seems to be well rooted in the public mind the idea that increased production per acre means a large total aggregate production and over production. This need not necessarily be the case. The point which is wished to be emphasized is that in order to get largest returns one must see to it that he gets at least moderately good yields per acre, and in order to do this he must use good seed and rational methods of maintaining and building soil fertility. If there is danger of over production, cut the acreage and produce more per acre, and in order to do this our soils must be built up. So this being the fact, our workers have devoted considerable attention, not only during the past year, but in previous years to securing specific information with reference to our soil needs for most profitable crop production and in giving this information out to the farmers of the State through carefully planned and conducted demonstrations on different farms in different sections of the State and in other ways. The same general plan of operation has been used in securing information with reference to what are our best varieties or types of our main crops for different sections of the State, and in giving this information to the people in the same general way. It is felt that one of the most effective ways of carrying information is through field demonstrations and by holding meetings at the demonstra-

tion fields at the end of the year to show what the different treatments or varieties or strains of crops have done comparatively, so as to bring out the special points it is wished to emphasize with the farmers of the community. For instance, if it has been realized that a certain treatment or variety of crop is best in a certain section on a particular type of soil in order to succeed best in the growing of a particular crop, then this fact or facts may be brought out by carefully conducted demonstrations at some good farm in the county or section where it is felt that the information needs to be emphasized.

The soil fertility demonstrations and better seed demonstrations have proven very effective means of impressing on many farmers of many communities in the State the importance of using particular methods of soil fertility building and of using better strains of different crops they have been growing.

OUTLINE OF FIELD WORK IN SOIL FERTILITY

Soil fertility investigations are being made by the Division of Agronomy on the following experimental farms:

At Mountain Branch Station, Swannanoa.

At Piedmont Branch Station, Statesville.

At Central Experiment Station, Raleigh.

At Edgecombe Branch Station, Rocky Mount.

At Washington (Blackland) Station, Wenona.

At Coastal Plain Station, Willard.

At Tobacco Branch Station, Oxford.

AT MOUNTAIN FARM

Field A—This experiment is designed to determine the most economical amounts of nitrogen, phosphoric acid, potash and lime to use on crops of corn, wheat and red clover grown in rotation.

Field B—This experiment is used to show comparison of the value of acid phosphate and rock phosphate as carriers of phosphoric acid on mountain valley soils when used alone, with cover crops and with stable manure. In the experiment the rotation of crops consists of corn, oats, wheat and red clover.

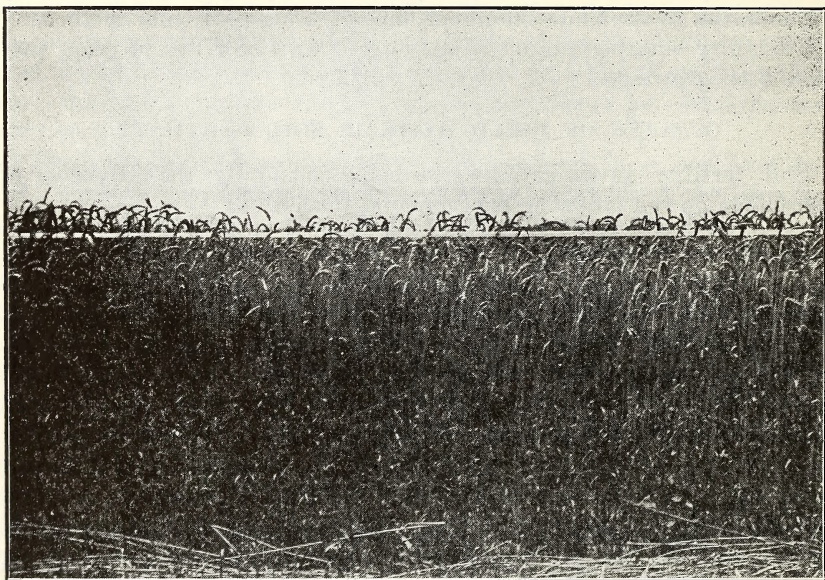
Field D (Continuous Corn).—On this field corn is grown every year and crimson clover is sown each fall and turned under in the spring in time to plant the corn. It is designed to show the relative value of acid phosphate and rock phosphate used with corn, when a clover crop is yearly turned under. Also to determine if all the nitrogen for large crops of corn can be secured by this method of handling the soil.

Field F.—This experiment is run to determine the best fertilizer formulas to use for different crops in a rotation consisting of Irish potatoes, corn, wheat, and red clover. Different amounts of nitrogen,

phosphoric acid, and potash are used in order to determine the best fertilizer formulas. Also muriate of potash, sulphate of potash and kainit are used as sources of potash for comparative purposes.

Field B (Rotation).—This field is used to study the effects upon yields of growing crops continuously on the same land and also of a two and three-year rotation with fertilizer. One end of this field has been limed to study the effect of lime with varying crop rotations.

Field G.—The object of the experiment is to study the relative efficiency of different carriers of phosphates with lime, without lime and with stable manure.



Wheat properly fertilized pays on the clay lands of the Piedmont Station.

AT PIEDMONT FARM

Fields A, B, and C.—These fields are used to determine for Piedmont soils the most profitable formulas and right amounts of fertilizer to use with and without lime, with a rotation of crops consisting of cotton, corn, wheat, and red clover. In the experiment acid phosphate, rock phosphate and basic slag are compared with and without manure. The effect of putting the fertilizer on at different times is also being studied.

Field D (Rotation).—This experiment is planned the same as that conducted on Field D at the mountain farm.

Field F (Nitrogenous Materials).—This experiment was started to compare the efficiency of some nitrogenous materials that are being used by the fertilizer companies in making their fertilizer mixtures.

Field G.—On this field the experiment is designed to show the relative effect of acid phosphate and different amounts of rock phosphate used, beginning with 500 pounds to the acre, once in every three years and going as high as an application of 3,000 pounds per acre once in every three years. The crops used on this field are: cotton, wheat, and red clover.

Field K (Soft Phosphate).—This field is used to study the comparative effects of acid phosphate and soft phosphate used on corn, cotton and wheat, grown in rotation.

AT CENTRAL EXPERIMENTAL FARM

Fields A and B.—These fields are used to study the effect of the use of different plant-food constituents and to determine the most economical fertilizer mixtures to use for cotton and corn in a three-year crop rotation in which soybeans are turned under once every three years and the land is limed once in every three years on one-half of all the plats.

Logan Field.—This experiment is designed to show the relative effect and value of burnt lime, hydrated lime, and limestone used in amounts of one, two and three tons per acre, applied every four years in a rotation of crops consisting of velvet beans, rye, cotton, cowpeas, oats, vetch, red clover, and crimson clover. In this experiment acid phosphate is added in sufficient amounts for large crops, and the rotation is designed with the hope of furnishing enough nitrogen for large crops by the growth and turning into the soil of the legumes grown.

Field D (Rotation).—The plan of this experiment is the same as that on Field D at the Piedmont (Iredell) Station.

AT EDGECOMBE FARM

Field A.—This field was used to work out the best fertilizer formulas and amounts of fertilizer to use for cotton, corn, oats and vetch in a three-year rotation, in which summer or winter legumes were grown every year. One-half of the field was limed once every three years to show the effects of the use of lime on the growth of legumes for building up the soil and on the efficiency of the fertilizer treatment.

Field B.—In this experiment a study was made of the relative efficiency of different carriers of phosphoric acid, with and without lime. The crop rotation used on this field was the same as for Field A of the same farm.

Field E.—This field is used to determine the plant-food deficiencies of the soils occurring in this part of the State.

Cotton Boll Weevil Experiment.—In this experiment, started in 1923, it is planned to show the effects of the use of varying amounts of phosphoric acid, nitrogen and potash in a complete fertilizer; also the effects of varying the amount of a complete fertilizer on the yield of

cotton. In this year's crop phosphates seem to have had some influence on early setting of bolls and maturity. The rest of the experiment has shown no striking results up to this time.

AT COASTAL PLAIN FARM

Field A.—On this field an experiment is being conducted for the purpose of determining what the main plant-food deficiencies of the soil are and to work out the best fertilizer combinations for cotton, corn, oats and vetch when grown in a three-year rotation in which summer and winter legumes are grown. One-half of all the field is limed once every three years to study the effect of the lime application upon the yields of the different crops grown under different fertilizer treatments.

Field B.—The experiment on this field is planned to study the relative efficiency of different common carriers of phosphoric acid used with and without lime. The rotation followed on this field is the same as that for Field A.

Field E.—This particular experiment is designed to show the plant-food deficiencies of the chief soil type occurring in this section of the State. Thus far, nitrogen has shown to be the main deficiency, although potash and phosphoric acid used with lime are necessary to be applied for best paying results with crops thus far grown.

AT BLACKLAND FARM

Field A.—In this experiment a study of the effects of the use of different fertilizer applications to corn, oats and Irish potatoes is being made. The field has been cut into three one-acre portions so as to have each crop growing each year with the different fertilizer applications.

Lime Field.—In this experiment burnt lime, marl and ground limestone are compared, using one, two and three tons and four tons per acre of each. Fertilizer is used on plats receiving limestone to determine if the use of fertilizers will pay on this soil.

Cultural Experiments.—In these experiments different crops are used with the land disked four inches, plowed eight inches, plowed eight inches and rolled, and plowed twelve inches and ridged.

Grass Plats.—This experiment consists of fifteen plats with the different mixtures of grasses that were thought might be of value for pasturage and hay purposes in this section of the State.

MISCELLANEOUS EXPERIMENTS

Experiments are being conducted to study the effect of lime, gypsum and potash on the yield of peanuts, and effect of the use of varying quantities as well as the composition of the fertilizer on the yield of cotton grown under boll weevil conditions. These experiments are

located in Mecklenburg, Anson, Union, Moore, Wake, Washington, Sampson, Cumberland, Craven, Beaufort, Pamlico, and Chowan counties.

Those designed to study the effect of the use of varying quantities of potash on corn are conducted in Pamlico and Union counties; effects of varying quantities of potash on wheat in Iredell, Davie and Rowan counties, and effect of gypsum and sulphate on alfalfa in Pitt County.

Results from coöperative work with the Bureau of Plant Industry on Wickham fine sandy loam in Cumberland County indicate that this soil is mainly deficient in potash and nitrogen, since additions of phosphoric acid show only small gains.



Unlimed plat at the Blackland Station, showing that lime is essential to the production of corn on muck soils.

In comparison of different forms of potash used under cotton, sulphate of potash gave the larger yield. Nine hundred pounds of an 8-4-4 fertilizer made larger and more profitable yields of cotton than did the use of smaller amounts.

In experiments near Whiteville on Norfolk sandy loam to determine the best variety of cotton and fertilizer formulas to use, indications are that under extreme boll-weevil damage in this section of the State, cultural methods alone will not suffice for profitable crop yields.

On Portsmouth fine sandy loam near Edenton the same experiment as above gave indications that fertilizers with a high phosphoric acid content were desirable.

At Roseboro on Marlboro fine sandy loam, and at Salemburg on Norfolk sandy loam the use of larger quantities of fertilizer were profitable. Both nitrogen and phosphates were found to be needed.

On the experiment to study the effect of the use of sulphate and gypsum on alfalfa, the results show no gain in yield over the use of lime and fertilizer alone.

In the experiment to study the value of potash on wheat when legumes were turned under on Cecil soils in Iredell County, where 24 pounds of actual potash were used per acre, the yield was somewhat larger than where 12 pounds of potash were applied. The increase in yield would more than pay for cost of the extra material used.

GENERAL DEDUCTIONS FROM SOIL FERTILITY INVESTIGATIONS

For Mountain Soils.—On all the soils studied, the use of phosphoric acid, nitrogen and lime, up to certain limits, has been found to profitably increase crop growth. Potash gives a small return after the other plant-food requirements have been met. Organic matter has been found to be very essential in increasing the crop producing power of these soils.

From the experimental results it is recommended that the following fertilizer formulas be used on corn and wheat for average soils:

FOR CORN—

On Uplands—400 to 600 pounds per acre analyzing 10 per cent phosphoric acid, 2 per cent nitrogen, and 1 per cent potash.

On Bottomlands—600 lbs. per acre analyzing 10 to 12 per cent P2O5, 1½ per cent nitrogen, and 1 per cent potash.

FOR WHEAT—

On Uplands—600 lbs. per acre analyzing 10 to 12 per cent P2O5, 2 to 3 per cent nitrogen.

On Bottomlands—600 lbs. per acre, analyzing 10 to 12 per cent P2O5, and 1 to 2 per cent nitrogen.

For Piedmont Soils.—The experimental results have shown very conclusively that the addition of phosphoric acid and nitrogen are absolutely necessary for most profitable crop yields. When potash is relatively cheap and other plant-food requirements are supplied, it will pay to use it in small amounts, especially so if crops of clover hay are taken off the land.

For best results in the growth of crops it is essential that these soils be supplied with larger contents of organic matter than many of them have at the present time. When this is done, the soils are easier to cultivate in both wet and dry weather, besides giving increased crop yields.

In order to grow crops to furnish organic matter successfully, especially the legumes, applications of lime have been found essential. Crop rotations should be used to include these legumes and the land should be occupied as much of the time as feasible with growing crops. This will tend to lessen very much the danger of washing to which these soils are subject.

Acid phosphate has been found to be the best source of phosphoric acid to use, basic slag coming next. Nitrate of soda and sulphate of ammonia have given greater crop yields than has the same amount of nitrogen supplied by other materials tried out furnishing nitrogen, but cotton seed meal has shown to be a very good source of nitrogen.

For Coastal Plain Soils.—Results gotten on the different types of soil occurring in this region have shown the need for the use of larger quantities of nitrogen and potash for larger crop productions than are commonly used by farmers in their fertilizer mixtures for most crops.

To keep the soil in a good physical condition and to decrease the loss from short drought periods, organic matter is necessary. It is very desirable to use legumes as far as possible to supply the organic matter. The use of lime has been found to be beneficial when applied in moderate quantities for promoting the growth of legumes.

With cotton it has been found to be advisable generally to use a larger quantity of more soluble nitrogen to hasten the maturity. Nitrate of soda and sulphate of ammonia are very efficient carriers for this purpose when they are used properly. More acid phosphate should also be used to help hasten the maturity of the cotton.

On the undrained and wooded areas suitable for pasture, a mixture of Japan clover and carpet grass is very good. On the higher soils Dallis grass can generally be used in the mixture successfully.

On soils in the Shale belt of North Carolina the use of potash in fertilizer mixtures is beginning to show up to great advantage for both cotton and corn. It would seem desirable for the farmers of the area to incorporate organic matter in the soil in order to assist the natural weathering processes to make more potash available from the inert supplies of these soils. The use of lime will also be found to be helpful for this purpose.

For Muck Soils.—Drainage still is and probably always will be of first consideration in crop production on these soils. Lime used at the rate of about two tons per acre every three years has been found to give much larger crop yields.

As the yield of corn seems to be gradually decreasing as the land is farmed, it is desirable to include in the crops grown a greater variety.

SOIL CHEMISTRY

The work in soil chemistry is mainly taken up in the study and solution of problems which arise in connection with the field experiments in soil fertility. During the year efforts have been largely devoted to the following three projects:

Project No. I.—The determination of the factors limiting crop production on the muck soils of eastern North Carolina and the development of practical methods for their control.

A study has been made of the effect of liming on the reaction of soils from the branch experimental farm at Wenona and the results have been submitted for publication as a technical bulletin. On this soil, lime applied at the rate of one, two, three, and four tons to the acre did not neutralize all the acidity, though the acidity was decreased in proportion to the amount of lime applied. The reaction brought about by the two-ton applications of lime made conditions as favorable for corn production as did the reaction following the use of four tons. In no cases did the yield from the limed plats exceed 50 per cent of the yield from the soil when first cleared. This fact indicates that some factor other than the reaction of the soil may be limiting the growth of corn on this land.

A series of pots was filled with the soil from the untreated plat of the lime test series at Wenona so that the soil and subsoil to a depth of ten inches were transferred without mixing. These pots were shipped to Raleigh, where different amounts of lime were applied and other treatments given to effect partial sterilization. No appreciable benefit was derived from partial sterilization. The corn planted in the unlimed pots made little or no growth. Pots receiving lime at the rate of 5 tons and 15 tons per acre produced stunted corn plants that showed evidence of the accumulation of iron compounds in the nodes similar to the effect produced by acid soils. The soils receiving 5 tons of lime per acre were distinctly acid, while those receiving 15 tons ranged from weakly acid to weakly alkaline.

On removal of the solid mass of soil from the pots it was found that the corn roots had failed to penetrate the acid subsoil, being matted into a dense layer at the bottom of the limed portion of the soil. This observation suggests that the solution of the problem of growing corn on these muck soils will be aided by the practice of liming to a greater depth than has been customary.

Tests of various combinations of fertilizers on pots receiving no lime and limed at the rate of 5 tons per acre, show that nitrate of soda and sulphate of potash in combination are beneficial, while acid phosphate is either without effect or injurious. Further work will show whether this result is due to the influence of these compounds on the tolerance of the corn plants to acid soil conditions or to an actual need for plant food.

Laboratory studies have shown that the acidity of the muck soils is due, to some extent at least, to the oxidation of the nitrogenous organic matter. The failure of heavy applications of lime to neutralize all of the acidity can be ascribed to the acceleration of this oxidation process by the lime applied.

Project No. II.—A study of the factors governing the availability of the potash in the common potash bearing minerals found in North Carolina soils.

The soil chosen was a Norfolk sandy loam, supposedly deficient in potash. Biotite and muscovite micas and orthoclase and microcline felds-

par were ground sufficiently fine to pass a 200-mesh screen before being mixed with the soil, though a number of pots received the mineral treatment at a fineness between 80 and 100 mesh for comparison with 200 mesh portions, to determine the effect of size of particles on availability of the potash content. Comparisons were provided for between the growth produced by the potash-bearing minerals, sulphate of potash and no potash additional to that contained in the soil. The accessory treatments included nitrate of soda, calcium nitrate, dried blood, and sulphate of ammonia, each with acid phosphate and with and without the addition of lime and stable manure. Soybeans and German millet were used as summer crops.

No results have been secured up to this time.

Project No. III.—A critical study of the results of chemical analyses and fertilizer requirements of the soil of different soil types of North Carolina.

The analyses of the soil survey samples have been listed and tabulated, grouping all analyses representing each soil type by the whole State and by counties. Further calculations have been delayed until the analytical work is completed on all the samples submitted.

It is evident from the tabulated results that while many of the soil types are characteristically well supplied with or deficient in one or more of the nutritive elements, there exist, within each type deviations from the average so great as to render questionable the invariable use of soil-type data as criteria of the fertilizer needs of that type.

RESULTS OF TOBACCO EXPERIMENTS

This work is carried on coöperatively with the office of Tobacco Investigations of the United States Department of Agriculture, and in the main all the experiments are conducted at Oxford and Reidsville.

Fertilizer Plots.—There are thirty-six 1/20 acre plats in this experiment, on which different sources of nitrogen, phosphoric acid and potash in different quantities are tested out. This is the thirteenth year that tests of this nature have been conducted at Oxford. For the past four years one-half of each of these plats has been limed with dolomitic limestone at the rate of 1 ton per acre broadcast.

A summary of the results from these tests shows that cottonseed meal as a source of nitrogen stands highest, with nitrate of soda, dried blood and sulphate of ammonia next in the order given. A mixed nitrogen application composed of one-fourth of each of the above materials gave satisfactory results. Acid phosphate gave better results than any of the other sources of phosphates tried out. Muriate of potash produced tobacco with a larger yield and higher market value than did tobacco grown with high grade sulphate of potash, although all tests have shown that sulphate of potash gave a better burning quality than that produced with muriate of potash. All plats gave an increased yield

with just as good or better quality on the end where dolomitic limestone was applied than where no lime was used.

Modified fertilizer tests were conducted this year at Reidsville and Clarkton. At Reidsville the results, where comparable, were similar to those secured at Oxford. The tests at Clarkton in Bladen County showed that 30 to 40 pounds of ammonia used with 40 to 50 pounds of potash per acre gave the best results. This was the first year's work at Clarkton and only some simple tests were tried out, nitrogen being derived one-third each from dried blood, cottonseed meal and nitrate of soda, and potash from true double manure salts.

Special Potash Tests.—A series of experiments comparing the different rates of application of potash derived from both sulphate and muriate consisting of ten $\frac{1}{2}$ -acre plats has been carried on for several years. One-half each of these plats were limed at the rate of 1 ton per acre of dolomite applied broadcast in April, 1923. The limed and unlimed plats were harvested separately.

The results again here have shown that muriate of potash gave better yields and values than did the use of sulphate of potash. Also, the use of from 36 to 40 pounds of potash per acre gave the largest returns, both on the limed and unlimed plats. A noticeable appreciation of potash starvation was observed on the limed end of the potash plats. As half of this field had lime applied to it in 1919, and no potash having been applied on these plats for the last ten years, indications are that the use of lime accentuated the exhaustion of available potash supply in the soils. Further, it is absolutely evident that a fairly liberal application of potash is essential for the most profitable growth of tobacco. Similar results to these were obtained at the Reidsville field.

Magnesium and Potash Plats.—This test consists of 18 plats on which were used Trona, muriate, German muriate, alunite, sulphate, German sulphate, double manure salts, and kainit applied each at the rate of 36 pounds of actual potash per acre. Ammonia from dried blood at the rate of 40 pounds per acre and phosphoric acid from acid phosphate at the rate of 64 pounds per acre were applied with the different carriers of potash. On one series of these plats, dolomitic limestone was used in the drill at the rate of 1,000 pounds per acre, and on the second series no lime at all was applied. On the third series calcite limestone was applied in the drill for comparative purposes at the rate of 1,000 pounds per acre. The object of this experiment has been to develop something that will prevent "sand-drown."

Where fairly liberal applications of magnesia were applied either derived from dolomitic limestone or from double manure salts and kainit no "sand-drown" trouble developed, except on the double manure salts plats where calcite was applied, and on those to which no lime was applied. On these two plats a small percentage of the plants developed symptoms of "sand-drown," indicating that the amount of available

magnesia was insufficient to mature the large growth of leaf which developed this season. Observations were made showing that where calcite was applied "sand-drown" was worse this year than where no lime was used, indicating that the use of calcium alone seemed to hasten the exhaustion of the magnesia supply of these soils somewhat similar in effect to that shown by exhaustion of potash supply as mentioned for special potash plats.

Duplication of this test was made at Reidsville and Clarkton with practically the same results, although the results were not so outstanding as at Oxford and Reidsville.



Special potash plats, Tobacco Experiment Station.

Special Fertilizer Tests.—This test consists of 12 plats on which was used C. P. chemicals. Its object was to test out the effects of sulphur, chlorine, magnesia, etc., on tobacco.

The results have not yet developed anything very positive, as this is only the second year of the test.

Variety Tests.—About 25 so-called varieties were tested out at Oxford. Some of them were distinct types, while others showed only minor differences. Selections and some crosses were made from each of these with the object of improving the yield and quality. The hybrids with which we have been working for the past two or three years are now showing a tendency to break up. Indications are that we may get some satisfactory results. These tests were also conducted this year at Reidsville and Clarkton.

Tobacco Rotations.—Very little can be added to our report of 1922 as to the results of the tests of crop rotation with tobacco. It is still felt that a rotation in which corn can be left out and small grains substituted more frequently in a three-year rotation will give excellent results. The experiments along this line are being continued, using two-, three-, and four-year rotations. It would appear that cotton might be added to this rotation advantageously, especially in the territory now affected with tobacco wilt.

Tobacco After Cowpeas.—This test consists of two one-half acre plats on which are grown cowpeas or soybeans every other year and plowed under. Tobacco is planted with different rates of applications of phosphoric acid and potash, but no commercial nitrogen is used.

Quantitative Magnesia Tests.—In order to determine the best amount of magnesia to recommend for the prevention of "sand-drown" and an increased yield, series of tests were put out at Oxford, Clarkton and Reidsville, using magnesium sulphate (epsom salts) at the rate of 20, 40, 60 and 80 pounds per acre, respectively, in addition to an application of complete fertilizer.

While the results are not as yet conclusive, indications are that 60 and 80 pounds of magnesium sulphate (20 to 27 pounds of magnesia) had a tendency to retard the growth during the early growing period. This might have been due to the very dry season during May and June. After the rains began, the tobacco with heavier applications of magnesium sulphate seemed to catch up with the tobacco on the other plats. The final weights and quality have not yet been determined.

Nutrition Plats.—This work is carried on in a series of tests consisting of ninety 1/40 acre plats in two fields to test out the effect of different cropping systems, viz., tobacco, cotton and corn, followed by wheat, oats, and rye. The object of this test is to determine the effect of the different small grain crops on the three major hoed crops and *vice versa*. On two other fields, series of one hundred and twenty-six 1/40 acre plats are being run to test out in the same way the effects of the different legumes, viz., cowpeas, soybeans, hairy vetch, crimson clover, as compared with grasses and fallow plats on tobacco, cotton and corn and the residual effects on wheat, oats and rye. These are extremely interesting tests, the results from which will be quite valuable, but it will take a number of years to get definite data in these more or less technical experiments.

SOIL TYPES OF NORTH CAROLINA FOUND SPECIALLY SUITED FOR GROWTH OF DIFFERENT CROPS

For many years the Division in its work has not only recognized the fact that each agricultural type of soil has not only its weak and strong points with reference to plant-food resources, but has been led to believe that by the preponderance of evidence that usually each of these

possesses certain peculiar characteristics which make it best suited for the growth of certain crops and the development of certain types of farming. This being the case, it would appear not to be out of place at this time to present below a list of crops best adapted for growth on some of the more or less leading types of soil mapped in North Carolina. The correlations thus far noted between crop adaptation and soil types are as follows:

IN COASTAL PLAIN REGION

Bladen Loam—Corn, cotton, oats, soybeans, and potatoes.

Bladen Clay Loam—Corn, hay, oats, rye, soybeans, cabbage, onions, and beets.

Bladen Silt Loam—Corn, cotton, oats, soybeans, and potatoes.

Bladen Silty Clay Loam—Corn, oats, and hay crops.

Bladen Fine Sandy Loam—Corn, oats, hay, Irish potatoes, cotton, soybeans, and tobacco.

Bladen Very Fine Sandy Loam—Corn, cotton, soybeans, oats, and Irish potatoes.

Bradley Sandy Loam—Cotton, corn, Irish potatoes, sweet potatoes, peanuts, oats, rye, vegetables, fruits, and tobacco.

Bradley Coarse Sandy Loam—Cotton, corn, cowpeas, sweet potatoes, oats, rye, peanuts, soybeans, crimson clover, watermelon, cantaloupes, velvet beans, and sorghum.

Bradley Gravelly Sandy Loam—Cotton, corn, oats, cowpeas, clover, soybeans, velvet beans, rye, vetch, sweet potatoes, fruits, and vegetables.

Cahaba Sandy Loam—Corn, cotton, soybeans, cowpeas, oats, rye, clover, fruits, and truck crops.

Coxville Loam—Corn, cotton, oats, soybeans, and rye.

Coxville Silt Loam—Grasses, corn, cotton, tobacco, oats, soybeans, and vegetables.

Coxville Clay Loam—Corn, oats, and soybeans.

Coxville Fine Sandy Loam—Corn, peanuts, tobacco, cotton, sweet potatoes, Irish potatoes, rye, vetch, soybeans, clover, strawberries, and vegetables.

Coxville Very Fine Sandy Loam—Corn, cotton, peanuts, oats, sorghum, cowpeas, soybeans, cabbage, strawberries, sweet and Irish potatoes, and grasses.

Dunbar Fine Sandy Loam—Peanuts, cotton, corn, tobacco, sweet potatoes, Irish potatoes, and vegetables.

Dunbar Very Fine Sandy Loam—Peanuts, cotton, corn, tobacco, sweet and Irish potatoes, clover, vetch, oats, cowpeas, and vegetables.

Greenville Sandy Loam—Cotton, corn, soybeans, and cowpeas.

Hoffman Sandy Loam—Cotton, corn, wheat, oats, sweet and Irish potatoes, peaches, dewberries, tobacco, sorghum, vegetables, cowpeas, soybeans, peanuts, clover, and velvet beans.

Hoffman Gravelly Sandy Loam—Cotton, corn, peaches, cowpeas, and soybeans.

Hyde Loam—Corn, oats, hay, cotton, sorghum, and vegetables.

Hyde Sand—Corn, celery, Irish potatoes, cabbage, and onions.

Hyde Mucky Loam—Corn, oats, celery, soybeans, cabbage, cotton, cowpeas, and vegetables.

Hyde Silt Loam—Corn, oats, cotton, soybeans, fruits, vegetables, potatoes, and cowpeas.

Hyde Very Fine Sandy Loam—Cotton, corn, oats, soybeans, potatoes, vegetables, fruits, grapes, and cowpeas.

Johnston Loam—Corn, nursery stock (chiefly fruit trees), oats, onions, cabbage, and celery.

Johnston Silt Loam—Corn, oats, grasses, cabbage, onions, and celery.

Kalmia Sand—Corn, cotton, and oats.

Kalmia Fine Sand—Peanuts, cotton, and corn.

Kalmia Sandy Loam—Corn, cotton, oats, tobacco, cowpeas, crimson clover, vetch, and rye.

Kalmia Fine Sandy Loam—Cotton, corn, oats, soybeans, cowpeas, peanuts, Irish and sweet potatoes, vegetables, and sorghum.

Lufkin Sandy Loam—Corn, cotton, cowpeas, peanuts, tobacco, fruits, and vegetables.

Lufkin Silt Loam—Peanuts, cotton, corn, sweet and Irish potatoes, garden vegetables, oats, rye, cowpeas, and soybeans.

Lufkin Fine Sandy Loam—Peanuts, cotton, corn, tobacco, sweet and Irish potatoes, garden vegetables, oats, rye, cowpeas, and soybeans.

Mattamuskeet Fine Sandy Loam—Early truck crops.

Mattamuskeet Silt Loam—Corn, oats, soybeans, cotton, celery, onions, cabbage, and pumpkins.

Mattamuskeet Very Fine Sandy Loam—Corn, oats, peanuts, sweet potatoes, cotton, cowpeas, soybeans, and cabbage.

Muck—Onions, corn, cabbage, and celery.

Myatt Sandy Loam—Cotton and corn.

Myatt Fine Sandy Loam—Corn, cotton, oats, cowpeas, and sorghum.

Norfolk Sand—Early truck crops, grapes, pecans, peaches, mulberries, watermelons, potatoes, cotton, corn, peanuts, cowpeas, tobacco, soybeans, rye, and chufas.

Norfolk Coarse Sand—Cotton, corn, tobacco, oats, forage crops, rye, cowpeas, early truck crops, watermelons, grapes, vegetables, fruits, and sweet potatoes.

Norfolk Fine Sand—Early truck crops, beans, sweet and Irish potatoes, radishes, lettuce, grapes, peanuts, small berries, asparagus, watermelons, cantaloupes, cotton, corn, soybeans, cowpeas, and rye.

Norfolk Loamy Sand—Cotton, corn, and some tobacco.

Norfolk Sandy Loam—Truck crops, tobacco, peanuts, grapes, sweet and Irish potatoes, cotton, soybeans, cowpeas, cantaloupes, beans, rye, crimson clover, watermelons, and grapes.

Norfolk Silt Loam—Cotton, corn, oats, rye, sweet and Irish potatoes, and vegetables.

Norfolk Coarse Sandy Loam—Peanuts, cotton, corn, tobacco, watermelons, cowpeas, oats, rye, clover, vetch, soybeans, sweet potatoes, cantaloupes, and fruits.

Norfolk Fine Sandy Loam—Late truck crops, peanuts, tobacco, cotton, corn, peaches, sweet potatoes, strawberries, grapes, crimson clover, soybeans, cowpeas, alfalfa, oats, rye, vegetables, and watermelons.

Norfolk Very Fine Sandy Loam—Cotton, corn, tobacco, fruits, late truck, clover, Irish and sweet potatoes, rye, cowpeas, soybeans, and grapes.

Ocklocknee Loam—Corn and grasses.

Okanee Silt Loam—Corn, cotton, cowpeas, oats, and celery.

Orangeburg Sandy Loam—Cotton, corn, tobacco, peanuts, sweet potatoes, cowpeas, oats, figs, peaches, and vegetables.

Orangeburg Fine Sandy Loam—Cotton, tobacco, corn, truck crops, peanuts, soybeans, sweet potatoes, vegetables, fruits, oats, sorghum, and cowpeas.

Orangeburg Gravelly Sandy Loam—Cotton, corn, peanuts, cowpeas, Irish potatoes, fruits, and vegetables.

Portsmouth Sand—Corn, cabbage, cucumbers, and grasses.

Portsmouth Fine Sand—Corn, Irish potatoes, cabbage, cucumbers, celery, and tomatoes.

Portsmouth Clay—Corn, vetch, cotton, oats, and clover.

Portsmouth Loam—Corn, cotton, oats, vegetables, potatoes, and lettuce. If properly drained, onions and celery may be grown.

Portsmouth Sandy Loam—Corn, cotton, oats, cabbage, onions, strawberries, cucumbers, vegetables, cowpeas, soybeans, Irish and sweet potatoes.

Portsmouth Clay Loam—Onions and corn.

Portsmouth Coarse Sandy Loam—Truck crops, corn, and oats.

Portsmouth Fine Sandy Loam—Corn, cotton, peanuts, tobacco, oats, strawberries, onions, cabbage, celery, soybeans, cowpeas, fruits, cucumbers, Irish potatoes, turnips, hay, and fruits.

Portsmouth Very Fine Sandy Loam—Corn, oats, cotton, strawberries, cucumbers, Irish potatoes, turnips, hay, and fruits.

Portsmouth Very Fine Sandy Loam—Corn, oats, cotton, strawberries, cucumbers, potatoes, cabbage, and turnips.

Parkwood Loam—Corn, oats, grasses, peanuts, cotton, and truck crops.

Parkwood Clay—Corn, alfalfa, and grasses.

Parkwood Fine Sandy Loam—Peanuts, cotton, corn, oats, sweet potatoes, fruits, and vegetables.

Parkwood Coarse Sandy Loam—Peanuts, Irish potatoes, cotton, corn, and truck crops.

Plummer Sandy Loam—Cotton, corn, oats, soybeans, cowpeas, sweet potatoes, and vegetables.

Plummer Fine Sandy Loam—Corn, cotton, Irish and sweet potatoes, peanuts, and melons.

Peat—Corn, celery, cabbage, and onions.

Ruston Sand—Cotton, corn, rye, tobacco, oats, sweet and Irish potatoes, and vegetables.

Ruston Sandy Loam—Cotton, corn, oats, cowpeas, soybeans, Irish and sweet potatoes, tobacco, grapes, rye, peanuts, and vegetables.

Ruston Gravelly Loam—Cotton, corn, oats, cowpeas, soybeans, rye, sweet potatoes, grapes, and vegetables.

Ruston Fine Sandy Loam—Cotton, corn, oats, sweet potatoes, peanuts, cowpeas, alfalfa, vetch, rye, clover, soybeans, fruits, and vegetables.

Ruston Coarse Sandy Loam—Cotton, peanuts, tobacco, corn, and potatoes.

Ruston Gravelly Sandy Loam—Truck crops, sweet potatoes, peanuts, cotton, corn, and grapes.

Ruston Very Fine Sandy Loam—Peanuts, cotton, corn, Irish potatoes, sweet potatoes, and vegetables.

Susquehanna Fine Sandy Loam—Cotton, corn, cowpeas, oats, crimson clover, soybeans, sweet potatoes, and vegetables.

Susquehanna Coarse Sandy Loam—Cotton, corn, sweet potatoes, peanuts, cowpeas, watermelons, grapes, berries, and apples.

Wickham Sand—Cotton, peanuts, and corn.

Wickham Coarse Sand—Corn, cotton, early vegetables, and watermelons.

Wickham Loam—Corn, cotton, soybeans, oats, and rye.

Wickham Silt Loam—Peanuts, soybeans, cotton, and corn.

Wickham Sandy Loam—Cotton, corn, oats, soybeans, cowpeas, peanuts, and sweet potatoes.

Wickham Fine Sandy Loam—Corn, cotton, oats, peanuts, sweet potatoes, rye, sorghum, cowpeas, soybeans, clover, and grasses.

Wickham Very Fine Sandy Loam—Corn, cotton, soybeans, peanuts, oats, and rye.

IN RIVER FLOOD PLAINS OF PIEDMONT AND COASTAL PLAIN

Congaree Loam—Corn, oats, cotton, wheat, soybeans, cowpeas, sorghum, and grasses.

Congaree Fine Sand—Corn, cotton, oats, rye, and soybeans.

Congaree Silty Clay Loam—Corn, grasses, and forage crops.

Congaree Silt Loam—Corn, cotton, oats, forage crops, sorghum, grasses, wheat, watermelons, and legumes.

Congaree Fine Sandy Loam—Corn, cotton, rye, oats, peanuts, clover, vegetables, wheat, soybeans, cowpeas, grasses, watermelons, and cantaloupes.

IN PIEDMONT REGION

Alamance Silt Loam—Cotton, wheat, rye, oats, corn, tobacco, grasses, Irish and sweet potatoes, sorghum, fruits, and vegetables.

Alamance Slate Loam—Corn, cotton, wheat, oats, rye, apples, pears, and peaches.

Alamance Gravelly Silt Loam—Wheat, corn, oats, cotton, clover, sorghum, sweet potatoes, Irish potatoes, vegetables, and fruits.

Alamance Very Fine Sandy Loam—Cotton, corn, soybeans, cowpeas, wheat, and tobacco.

Altavista Loam—Cotton, corn, oats, wheat, and hay.

Altavista Silt Loam—Corn, wheat, oats, grasses, and cotton.

Altavista Fine Sandy Loam—Cotton, corn, oats, soybeans, cowpeas, grasses, forage crops, and rye.

Altavista Very Fine Sandy Loam—Cotton, corn, and peanuts.

Appling Sandy Loam—Corn, wheat, tobacco, cotton, oats, clover, sweet potatoes, Irish potatoes, grapes, sorghum, soybeans, cowpeas, rye, grasses, truck crops, fruits, and cantaloupes.

Appling Fine Sandy Loam—Corn, wheat, tobacco, cotton, oats, clover, sweet potatoes, Irish potatoes, fruits, sorghum, soybeans, cowpeas, rye, and vegetables.

Appling Gravelly Sandy Loam—Tobacco, corn, cotton, watermelons, cantaloupes, sweet potatoes, truck crops, peaches, dewberries, and blackberries.

Appling Coarse Sandy Loam—Tobacco, oats, rye, wheat, cotton, corn, sweet potatoes, Irish potatoes, vegetables, peaches, apples, cowpeas, soybeans, peanuts, sorghum, and clover.

Appling Very Coarse Sandy Loam—Cotton, corn, oats, clover, cowpeas, soybeans, grasses, garden and truck crops, sorghum, and fruits.

Bermudian Loam—Cotton, corn, cowpeas, hay, oats, rye, and sorghum.

Bermudian Silty Clay Loam—Native hay, corn, and some cotton.

Caswell Sandy Loam—Tobacco, truck crops, potatoes, clover, corn, wheat, oats, cowpeas, and soybeans.

Cecil Clay—Wheat, corn, oats, cowpeas, clover, grasses, soybeans, sorghum, apples, cherries, and pears.

Cecil Clay Loam—Corn, cotton, wheat, oats, rye, clover, grasses, cowpeas, soybeans, sorghum, cabbage, turnips, potatoes, apples, cherries, pears, alfalfa, and Irish potatoes.

Cecil Sandy Clay Loam—Cotton, corn, wheat, oats, cowpeas, clover, soybeans, sorghum, cabbage, turnips, potatoes, apples, cherries, pears, alfalfa, and Irish potatoes.

Cecil Loam—Corn, cotton, oats, wheat, cowpeas, sweet potatoes, Irish potatoes, fruits, vegetables, tobacco, and clover.

Cecil Sandy Loam—Corn, cotton, wheat, tobacco, oats, clover, grasses, Irish and sweet potatoes, peaches, apples, grapes, rye, sorghum, vegetables, fruits, cowpeas, soybeans, and cantaloupes.

Cecil Fine Sandy Loam—Cotton, melons, truck crops, corn, wheat, oats, cowpeas, clover, tobacco, sorghum, rye, fruits, sweet potatoes, Irish potatoes, and wheat.

Cecil Coarse Sandy Loam—Cotton, corn, wheat, oats, rye, clovers, cowpeas, tobacco, sweet potatoes, Irish potatoes, peanuts, small fruits, apples, peaches, and early truck crops.

Cecil Gravelly Loam—Cotton, corn, oats, cowpeas, vegetables, sorghum, sweet potatoes, grapes, peaches, apples, wheat, rye, and tobacco.

Cecil Gravelly Sandy Loam—Cotton, corn, cowpeas, soybeans, and clover.

Cecil Very Coarse Sandy Loam—Corn, cotton, wheat, oats, tobacco, sweet potatoes, vegetables, apples, peaches, clover, cowpeas, soybeans, and rye.

Cecil Stony Loam—Corn, wheat, rye, cowpeas, apples, and peaches.

Cecil Stony Sandy Loam—Corn, clover, soybeans, cowpeas, sweet potatoes, Irish potatoes, wheat, tobacco, and cotton.

Cecil Stony Clay Loam—Cotton, corn, oats, soybeans, and cowpeas.

Cecil Stony Fine Sandy Loam—Cotton, corn, oats, soybeans, and cowpeas.

Conowingo Silt Loam—Corn, wheat, oats, cotton, tobacco, soybeans, cowpeas, clovers, grasses, fruits, and vegetables.

Conowingo Gravelly Silt Loam—Corn, wheat, cotton, oats, clovers, sorghum, fruits, and vegetables.

Davidson Clay—Wheat, corn, cotton, oats, clover, soybeans, and cowpeas.

Davidson Clay Loam—Corn, wheat, oats, cotton, grasses, clovers, tobacco, alfalfa, soybeans, cowpeas, vegetables, fruits, Irish potatoes, sweet potatoes, and sorghum.

Durham Sandy Loam—Cotton, tobacco, wheat, cabbage, peanuts, clovers, rye, oats, cowpeas, soybeans, peaches, pears, apples, sweet potatoes, Irish potatoes, sorghum, vegetables, vetch, and grapes.

Durham Fine Sandy Loam—Tobacco, corn, wheat, oats, cotton, clovers, cowpeas, soybeans, sweet potatoes, Irish potatoes, vegetables, sorghum, peanuts, clovers, rye, watermelons, cantaloupes, and fruits.

Durham Coarse Sandy Loam—Corn, wheat, tobacco, sweet potatoes, Irish potatoes, red clover, fruits, vegetables, rye, oats, cowpeas, cotton, vetch, peanuts, soybeans, sorghum, and grapes.

Durham Gravelly Sandy Loam—Cotton, corn, soybeans, cowpeas, and rye.

Georgeville Gravelly Loam—Corn, cotton, oats, soybeans, cowpeas, and rye.

Georgeville Slate Loam—Cotton, corn, grasses, soybeans, cowpeas, and rye.

Georgeville Silt Loam—Corn, oats, cotton, rye, wheat, peanuts, clovers, grasses, cowpeas, sweet potatoes, Irish potatoes, vegetables, sorghum, apples, pears, peaches, and tobacco.

Georgeville Clay Loam—Cotton, corn, soybeans, grasses, cowpeas, and rye.

Georgeville Silty Clay Loam—Wheat, corn, oats, cotton, sorghum, vegetables, cotton, sweet potatoes, clovers, grasses, fruits, cowpeas, and soybeans.

Georgeville Gravelly Silt Loam—Wheat, corn, oats, clovers, fruits, vegetables, cotton, sweet potatoes, Irish potatoes, tobacco, and grasses.

Granville Silt Loam—Cotton, corn, Japan clover, sorghum, oats, soybeans, grasses, vegetables, and fruits.

Granville Sandy Loam—Cotton, tobacco, corn, cowpeas, oats, sweet potatoes, and vegetables.

Granville Fine Sandy Loam—Cotton, corn, tobacco, cowpeas, oats, sweet potatoes, vegetables, soybeans, velvet beans, wheat, and sorghum.

Granville Gravelly Loam—Cotton, corn, oats, rye, soybeans, and cowpeas.

Granville Coarse Sandy Loam—Tobacco, corn, cotton, wheat, oats, sweet potatoes, Irish potatoes, peanuts, apples, plums, and peaches.

Granville Gravelly Sandy Loam—Corn, wheat, sweet potatoes, rye, crimson clover, peanuts, fruits, and vegetables.

Iredell Loam—Small grains, corn, cotton, tobacco, cowpeas, clovers, and grasses.

Iredell Sandy Loam—Oats, wheat, rye, grasses, corn, sorghum, tobacco, cotton, Irish and sweet potatoes, and vegetables.

Iredell Clay Loam—Corn, oats, grasses, cotton, wheat, rye, soybeans, and cowpeas.

Iredell Stony Loam—Grasses, corn, potatoes, vegetables, wheat, oats, rye, soybeans, and cowpeas.

Iredell Fine Sandy Loam—Wheat, oats, rye, corn, grasses, cotton, tobacco, clovers, sweet potatoes, Irish potatoes, fruits, cowpeas, soybeans, and vegetables.

Louisa Loam—Corn, wheat, oats, rye, Irish potatoes, sweet potatoes, cotton, tobacco, soybeans, cowpeas, fruits, vegetables, clover, and grasses.

Louisa Clay Loam—Cotton, corn, soybeans, cowpeas, and rye.

Louisa Silt Loam—Cotton, corn, wheat, oats, cowpeas, grasses, vegetables, and fruits.

Louisa Sandy Loam—Corn, cotton, sweet potatoes, watermelons, and vegetables.

Louisa Gravelly Loam—Cotton, corn, wheat, rye, oats, cowpeas, clovers, and grasses.

Mecklenburg Loam—Corn, cotton, rye, oats, wheat, clovers, grasses, and tobacco.

Mecklenburg Sandy Loam—Cotton, corn, wheat, oats, and cowpeas.

Mecklenburg Clay Loam—Cotton, wheat, oats, clovers, corn, soybeans, and cowpeas.

Penn Silt Loam—Cotton, corn, rye, oats, and wheat.

Wadesboro Loam—Cotton, corn, oats, cowpeas, rye, wheat, and apples.

Wadesboro Clay Loam—Cotton, oats, rye, soybeans, corn, wheat, grasses, and clover.

Wadesboro Silt Loam—Corn, cotton, wheat, rye, oats, tobacco, sweet potatoes, Irish potatoes, vegetables, and fruits.

Wadesboro Fine Sandy Loam—Cotton, corn, cowpeas, oats, rye, soybeans, clovers, rye and sweet potatoes.

Wadesboro Gravelly Sandy Loam—Cotton, corn, cowpeas, peanuts, and peaches.

Wehadkee Silt Loam—Corn, oats, and grasses.

Wehadkee Silty Clay Loam—Native hays, and corn.

White Store Clay Loam—Cotton, corn, oats, soybeans, cowpeas, and sorghum.

White Store Fine Sandy Loam—Cotton, corn, wheat, oats, rye, vegetables, sweet potatoes, watermelons, peanuts, soybeans, and cowpeas.

Wilkes Sandy Loam—Tobacco, corn, cotton, wheat, oats, rye, soybeans, cowpeas, vetch, red clover, sorghum, sweet potatoes, Irish potatoes, vegetables, and fruits.

Wilkes Coarse Sandy Loam—Tobacco, corn, small grains, soybeans, cowpeas, red clover, sweet potatoes, Irish potatoes, sorghum, vegetables, and fruits.

IN MOUNTAIN REGION

Ashe Loam—Corn, wheat, rye, oats, grasses, Irish potatoes, buckwheat, apples, peaches, and vegetables.

Ashe Sandy Loam—Corn, oats, and some garden crops.

Ashe Stony Loam—Corn, apples, peaches, Irish potatoes, vegetables, and apples.

Chandler Loam—Corn, wheat, rye, buckwheat, hay, Irish potatoes, sorghum, soybeans, oats, apples, and vegetables.

Chandler Stony Loam—Corn, rye, oats, wheat, buckwheat, and apples.

Clifton's Stony Loam—Hay, corn, rye, and buckwheat.

Porter's Loam—Corn, wheat, buckwheat, rye, red clover, grasses, oats, vegetables, apples, peaches, and Irish potatoes.

Porter's Clay—Corn, wheat, soybeans, red clover, grasses, cowpeas, oats, rye, Irish potatoes, and vegetables.

Porter's Clay Loam—Grasses, red clover, corn, wheat, cabbage, Irish potatoes, turnips, soybeans, buckwheat, rye, oats, sorghum, apples, and grapes.

Porter's Sandy Loam—Corn, wheat, soybeans, oats, buckwheat, Irish potatoes, vegetables, and fruits.

Porter's Fine Sandy Loam—Corn, wheat, apples, and peaches.

Porter's Stony Loam—Corn, hay, wheat, soybeans, buckwheat, rye, oats, fruits.

Talladega Loam—Corn, rye, Irish potatoes, wheat, buckwheat, oats, vegetables, sorghum, and apples.

Talladega Clay Loam—Corn, wheat, buckwheat, Irish potatoes, rye, oats, grasses, sorghum, and vegetables.

Talladega Stony Loam—Corn, wheat, rye, oats, Irish potatoes, vegetables, grasses, apples, and peaches.

Toxaway Loam—Hay, corn, wheat, rye, soybeans, cowpeas, Irish potatoes, and vegetables.

RESULTS OF EXPERIMENTAL WORK IN CROP IMPROVEMENT

Adams Project No. 14.—The results from previous field work on the study of inheritance and association of economic qualities in cotton are being prepared for publication. On account of the large number of qualities studied, it is considered best to divide the problem into several articles, each dealing with one quality and its relation to the other qualities studied. The work accomplished during the year consists of the completion of articles on yield and seasonal influence upon strain yields, earliness and associated qualities, lint percentage and lint index, and inheritance of the fuzzy seed coating. Further work has been done on perfecting a method for determining the density of fiber population on the cotton seed coat. The method of using a sharpened leather punch for cutting out a section of the seed coat and counting the fibers has been found to be very satisfactory. This instrument makes it possible to quickly determine the density of cotton fibers on any portion of the seed coat or on any seed of the locks of cotton. It is much superior to methods previously recommended by Huson and Leake, in which the area of the seed must be determined. The fact that the cotton seed does not accurately approach any geometric figure makes it difficult to calculate its area by mathematical formulae which takes into account only the length and breadth of the seed.

Work on Branch Station Farms.—The field crop work on the branch station farms has consisted of seed improvement, culture tests, strain tests and trials of new and promising crops. On each of the seven branch station farms one or more of the principal crops of the State is being improved for that particular section. The seed from these farms are supplied to Extension Service workers in small quantities, and are included in the community variety tests of the Division of Agronomy of that service. As far as practical, the seed of each farm is included in the community tests in the section of the State represented by the farm. In this way the State seed must come in competition with seed of the best southern breeders and those commonly used in the community. If the station seed yield the best and are chosen as the standard variety for the community in question, seed are then sold from the farm at a price which will not cause undue competition with local seed breeders. All of

the best breeders of the State are using strains of field crops that were started on the branch station farms. In order to keep up the standard of these seed, field selections and plant-to-row plantings are made each year. Careful records are also kept regarding the standing of these strains in the various communities. During the past three years the demand for pedigreed cotton seed, abruzzi rye, oats, seed corn, and soybeans has been greater than the supply on those farms.

The culture studies have consisted of spacing tests of cotton and its relation to yield, earliness, and quality of lint. In the past seasons' tests close spacing yielded highest, though it furnishes a slightly shorter staple.

The Division has coöperated with the various offices of the United States Department of Agriculture and Experiment Stations in the exchange of field crop seed. Among the new crops secured in this way are: Subterranean clover, Seredella, Mung bean, soybeans and velvet beans from the office of Forage Crop Investigations; wheat from the Alabama Experiment Station; wild white clover from Scotland; and Lespedeza No. 76 from the Tennessee Experiment Station. The Subterranean clover continues to do well, it making a very good early growth this spring. The present indications are that it will be good for early pasturage or soil improvement. Seredella has not been able to compete with burr clover or crimson clover under the conditions existing at the Central Station farm. The different varieties of the mung bean have shown considerable differences in the amount of growth and earliness, but none of them will likely be preferred over the soybean on account of its smaller yield of seed. Among the new soybeans tested, the Laredo has proven the most promising.

The Alabama Blue-Stem wheat secured through the Alabama Station has continued to give good results in the variety tests. Seed of this variety were increased during the past season. The field was thoroughly rogued for mixtures of other grain and head selections were made.

Lespedeza No. 76, from the Tennessee Station, has been distributed to two sections of the State and is being increased for seed purposes. During the past two seasons it has been found to be superior to ordinary lespedeza on account of its larger and more upright habit of growth.

Plant-to-row breeding work was started this season with the Honey variety of sorghum. This variety has in comparative field tests proved to be one of the heaviest yielders of juice and syrup. The selections have shown some variation in earliness and considerable differences in the weight of material harvested from pedigreed rows. The data upon juice and syrup yields has not yet been taken.

The pure lines of Mammoth Yellow No. 101, Haberlandt No. 38, and Virginia No. 11, have continued to yield better than the strains from which they have been selected. Strain No. 101 has averaged seven bushels more than the ordinary seed; Haberlandt No. 38, four and one-

half bushels more; and Virginia No. 11, three bushels per acre more than the ordinary seed during the past five years.

Some very promising selections have come from a chance cross between the Virginia and Haberlandt soybean varieties. Among these is an upright strain having the Virginia habit of growth and the Haberlandt color of seed. The new type is superior to the old type of Virginia in that it stands more upright, thereby being more easily harvested for seed or hay.

PUBLICATIONS

In addition to the hundreds of timely articles and mimeographed tabulations of field results prepared for use by farmers, newspapers, scientific journals and other publications, the following publications have been prepared, embodying the findings and recommendations of workers of the Division:

1. Growing Red Clover in North Carolina. Extension Circular No. 136.
2. Results of Fertilizer Experiments with Corn on Toxaway Loam (Bottomland) and Porter's Loam (Upland) Soils in the Mountains (1911-1917, inclusive), N. C. State Department of Agriculture Bulletin for October, 1922.
3. Results of Fertilizer Experiments with Wheat on Piedmont Clay and Clay Loam Soils (1911-1921, inclusive), N. C. State Department of Agriculture Bulletin for November, 1923.
4. Nitrification and Acidity in Muck Soils of Eastern North Carolina. Technical Bulletin No. 24.
5. Soil Survey Reports on the Soils of Camden, Currituck, Sampson, and Polk Counties.

In closing this report, I wish to give credit to all the workers of the Division for the faithful and conscientious way in which they each have performed the work in which they were engaged. The work has been carried on aggressively by W. F. Pate, L. G. Willis, S. K. Jackson, and H. B. Mann in soil fertility; by R. Y. Winters, P. H. Kime, S. W. Hill, and G. M. Garren in crop improvement; and S. F. Davidson and W. A. Davis in soil survey.

Respectfully submitted,

C. B. WILLIAMS,
Chief, Division of Agronomy.

REPORT OF ANIMAL INDUSTRY DIVISION

To the Director:—I am pleased to submit herewith a report of the activities of the Animal Industry Division covering both Experiment Station and Extension Work from December 1, 1922, to November 30, 1923, inclusive.

This report is purely a statement of the progress which has been made in these two phases of Animal Industry work, no attempt being made to go into the details more especially of the several outstanding projects in research which are being conducted. This would not only entail much space, but bring into question the development of projects some of which are not yet sufficiently complete to draw any definite conclusions. In the research work, therefore, I am simply outlining the problems under way and where possible drawing certain definite conclusions where justified in doing so.

In the Extension phases of the work a rather complete summary is attached, showing the magnitude of the work under way and the results which have been accomplished up to date. The fact that all Animal Industry Extension Work is on a definitely outlined project basis, a copy of which is just now going to all county agents, showing the plans for the 1924 work, makes it possible to give a clear, concise summary of all activities.

A summary of the work of each specialist is given on the following pages, each occupying a definite section of the report. If you are desirous of securing additional information on any particular section of the report or on the report as a whole, I will be pleased to furnish it upon request.

ANIMAL NUTRITION

J. O. HALVERSON, *in Charge*

Assistants: F. W. SHERWOOD and B. NAIMAN

I. *Soft Pork Studies.*

The following experiments on this project, in coöperation with Mr. Hostetler, in charge of Swine Husbandry Research, have been completed or are under way at present:

(a) Soft Pork Experiment VII.

For effect of various amounts of peanuts on body carcass, ten pigs 60 to 80 pounds in weight were fed individually for approximately 115 days.

Smaller pigs of weaning age are now being used to study by the same method, the effect of peanut feeding.

(b) Soft Pork Experiment VIII.

For effect on body carcass of the same quantity of peanuts being fed to each pig, four pigs averaging 125 pounds each were individually fed for about 195 days.

1. Two of these pigs were fed equal quantities of peanuts, followed by the same quantity of rice as is done in feeding practice.

2. The other two pigs were likewise fed equal quantities of both feeds made up into a nutritively complete ration. This was fed throughout the experiment.

(c) Soft Pork Experiment VIII-b.

The adequacy of the proteins in peanut meal for supporting growth when fed a properly otherwise supplemented ration was tried on a 60-pound pig.

The adequacy of the peanut proteins alone in a ration otherwise properly supplemented is also being studied with good results on two stunted pigs of weaning age. This is in confirmation of our peanut studies with the albino rat.

(d) Soft Pork Experiment IX.

For the effect on body carcass of corn and rice feeding following peanut feeding, pigs of weaning age are being used.

II. *The Feeding Value of Cotton Seed Meal and Hulls for Dairy Cows.*

This project, in coöperation with Mr. Stanley Combs, in charge of Dairy Cattle Investigations, and Mr. R. S. Curtis, in charge of Beef Cattle Investigations, has been actively pursued on fifteen cows, using ten supplements in various forms such as casein, yeast, butterfat, cod liver oil, steamed bone meal and precipitated chalk.

Results: Of these 15 head, 5 were heifers, of whom two have now produced living calves, still active and doing well. No spasms or convulsions have occurred this year on supplements. No deaths have occurred. Two cows have been saved from death by adequate supplements being added to the ration of cotton seed meal and hulls.

Cotton seed meal and hulls are nutritively deficient in feeding value. The small amount of 5 and 10 per cent alfalfa in the form of a meal added to the ration of cotton seed meal, hulls, and oats in a descending scale, produced the two living calves from heifers. This has not been successfully done before without the presence of alfalfa meal.

III. *Onion Flavor in Milk.*

Further work was done in coöperation with Mr. Combs on the removal of onion flavor from milk by using Mrs. Lea's Milk and Butter Purifier, a proprietary mixture with only partial success in a number of trials.

IV. *The Nutritive Quality of Butter from Cows Fed Exclusively on Dry Feed, Cotton Seed Meal and Hulls.*

This coöperative project is being studied, using the albino rat with highly purified rations. Satisfactory results so far have not been obtained, due to trouble with our ration and technique.

V. *The Nutritive Value of the Peanut.*

Further studies have been pursued to a limited extent. The effect upon growth and reproduction of adding alfalfa leaf to peanuts when properly supplemented in other respects, is being studied by feeding this ration to the albino rat.

VI. *Publications—Year 1923.*

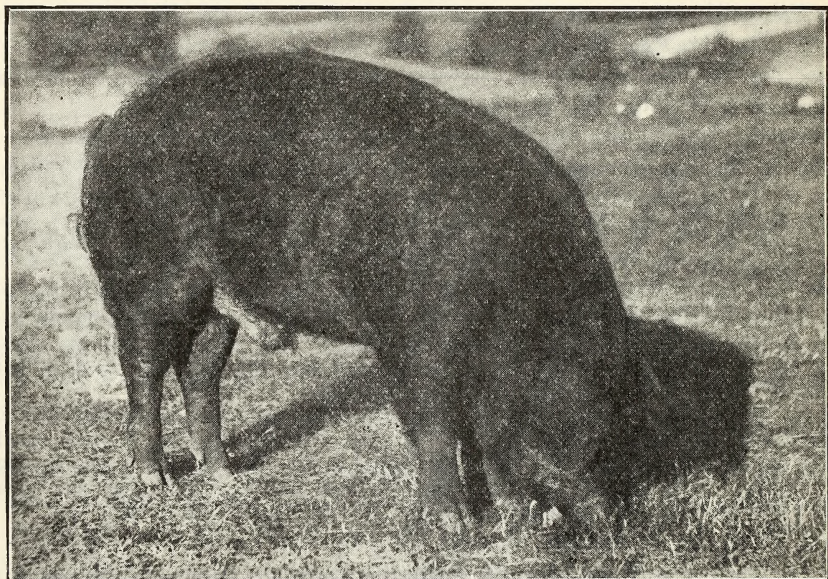
- (a) The Importance of Lime for Agriculture Released to the State Press (April).
- (b) The Relation of Diet to the Development and Preservation of Teeth. F. W. Sherwood, N. C. Academy of Science, Greensboro, N. C., May 4.
- (c) Methods for the Determination of Calcium in Feeds Compared. J. O. Halverson and L. M. Nixon, American Chemical Society, Local Section, N. C. Academy of Science, May 5th.

SWINE RESEARCH

E. H. HOSTETLER, *in Charge.*

Assistant: L. T. MILLER.

The Swine Research Work is now being conducted on a much more effective and satisfactory basis than ever before, largely on account of the acquisition of a 72-acre farm, well equipped with buildings to conduct the various phases of the work. For the last year or more the buildings have been undergoing alterations, looking especially to their adaptation for conducting research work with swine.



Boar, N. C. Ultimus No. 185989. Bred and owned by the Animal Industry Division at the Swine Research Farm, Raleigh, N. C. This boar was Senior and Grand Champion at the 1921 N. C. State Fair and first in his class at the 1923 Fair. His get have proven him to be an extraordinary sire.

In addition to the alteration of buildings the farm has been almost completely refenced into lots and pastures in such a way that all hogs used in the various projects could be produced on the farm as well as conduct the various specific pieces of research work formerly outlined.

The special experiments conducted during the last year are as follows:

I. Soft Pork Studies.

The following experiments on this project in coöperation with Dr. Halverson, in charge of Animal Nutrition, have been completed or are under way at present.

(a) Soft Pork Experiment VII.

For effect of various amounts of peanuts on body carcass, ten pigs 60 to 80 pounds in weight were fed individually for approximately 115 days.

Smaller pigs of weaning age are now being used to study by the same method the effect of peanut feeding.

(b) Soft Pork Experiment VII.

For effect on body carcass of the same quantity of peanuts being fed to each pig, four pigs averaging 125 pounds each were individually fed for about 195 days.

1. Two of these pigs were fed equal quantities of peanuts followed by the same quantity of rice as is done in feeding practice.

2. The other two pigs were likewise fed equal quantities of both feeds made up into a nutritively complete ration. This was fed throughout the experiment.

(c) Soft Pork Experiment VII-b.

The adequacy of the proteins in peanut meal for supporting growth when fed a properly otherwise supplemented ration was tried on a 60-pound pig.

The adequacy of the peanut proteins alone in a ration otherwise properly supplemented is also being studied with good results on two stunted pigs of weaning age. This is in confirmation of our peanut studies with the albino rat.

(d) Soft Pork Experiment IX.

For the effect on body carcass of corn and rice feeding following peanut feeding, from pigs of weaning age are being used.

II. *Soft Pork Studies (with Bureau of Animal Industry).*

Object: To determine the effect upon the carcasses of 75 to 100 pigs which have been fed peanuts or soybeans for eight weeks with a subsequent feeding on corn and tankage for twelve weeks.

Plan: To use two lots containing 12 pigs each—one lot to be fed on soybeans plus 2½ per cent of shell corn for 8 weeks and finished on corn and tankage for 12 weeks. The other lot is to be fed peanuts from a self-feeder in a dry lot for 8 weeks and then finished on corn and tankage for 12 weeks. Three pigs out of each lot were killed at the close of the grazing period, and thereafter the killings were made every four weeks using the same number of pigs.

Record: The pigs in Lot I, that were fed peanuts, made an average daily gain of 1.38 pounds during the grazing period, and 1.65 pounds daily gain during the finishing period. The pigs on soybeans gained only 1.17 pounds per pig per day during the grazing period, but made an average daily gain of 2.01 pounds after being put in the finishing lot.

Results: Neither lot of pigs killed out strictly hard.

III. *Coöperative Soft Pork Work (Southern Experiment Stations).*

This station is still coöperating with a number of southern experiment stations as well as the Bureau of Animal Industry in the Soft Pork Problem. Mr. Hostetler was reappointed to serve on the grading committee to represent the southern experiment stations in the work.

IV. *Exhibit at State Fair.*

Eight hogs from the Swine Farm were exhibited at the State Fair and competed in a creditable manner, not only with other State herds, but several out of State herds, winning a total of \$82.

EDGECOMBE TEST FARM

The plans for the hog work at this farm have been changed completely during the past year, and at present the program is practically completed with the exception of some fencing.

A new central farrowing house, with lots adjacent, has been completed, and five three-acre paddocks have been fenced for experimental crops.

Also the grade herd of hogs has been disposed of and we now have a pure bred herd of Hampshires. The new equipment was not in place early enough to permit of much experimental work, although we are continuing the cost of raising pigs to weaning time (8 weeks), and also conducted one test with sweet potatoes as follows:

I. Sweet Potatoes for Fattening Pigs.

Object: To determine—

- (a) The value of sweet potatoes when fed to pigs.
- (b) The effect of sweet potatoes upon the carcasses.

Plan: To use two lots of ten pigs each, feeding Lot I on sweet potatoes and fish meal, and Lot II on sweet potatoes, 2 per cent corn, and fish meal.

Record: The pigs in Lot I made an average daily gain of 1.14 pounds per day, while the pigs in Lot II made an average daily gain of only 1.05 pounds. The pigs in Lot I averaged 66 pounds at the beginning of the experiment, and the pigs in Lot II 64.5 pounds.

With corn at \$1 per bushel, and fish meal at \$60 per ton, the sweet potatoes were worth \$0.34 per bushel in Lot I, and \$0.25 per bushel in Lot II. Both lots of pigs were sold locally, and were sold at a premium because of the quality and finish of the carcasses.

BLACK LAND BRANCH EXPERIMENT STATION

The feeding experiments at this farm this year were broken into because of a severe infestation of worms in the pigs. However, we were able to overcome this difficulty by the use of grazing crops. The pigs that were kept on pasture gained rapidly and kept in good health, while those that were kept in a dry lot on a self-feeder were very unthrifty and made practically no gains until after they were treated with a worm remedy and put out on pasture.

We are using the individual farrowing houses at this farm, and have seven lots and houses completed in addition to four three-acre paddocks for grazing crops.

PIEDMONT BRANCH STATION

At this farm there has also been a complete renewal of all of the swine equipment. Eight new individual houses with lots have been built for the sows in addition to a house and alfalfa paddock for the boar. Also a new feed house has been built and four acres seeded to alfalfa and three acres to red clover for use in the swine work.

We are continuing the "Cost of Raising Pigs to Weaning Time" (8 weeks), and also have an experiment in progress relative to the value of soybeans for pigs when supplemented with corn and fish meal.

This latter work has been summarized and brought up to date in a bulletin issued by the North Carolina Experiment Station in July, 1922. The serial number of the bulletin is 244. Likewise, the work which has been done on the various test farms to determine the best methods of feeding farm work animals has been summarized in the September, 1922, bulletin under the title of Feeding Farm Work Animals.

MISCELLANEOUS WORK

Number of letters written.....	1,050
Number of articles in papers.....	12

DAIRY CATTLE RESEARCH

STANLEY COMBS, *in Charge*I. *Cottonseed Meal Feeding Work.*

The work on the effect of cottonseed meal upon the growth and reproduction of cows is progressing very nicely with the coöperation of Mr. R. S. Curtis, of the office of Beef Cattle and Sheep, and Dr. J. O. Halverson of the office of Animal Nutrition.

Only three of the cows have calved this fall. Each calf seems to be fully matured and normal in every respect. During the past year the herd has been free from spasms, and only a few animals have been sick or off feed. Doubtless this has been brought about by the supplements and adjuvants used in this year's ration.

Two of the above cows that have recently calved have consumed in proportion to their live weight 50 per cent more cottonseed meal during the period from April 15th to October 15th than the cows at a similar age in our original herd. They produced what appear to be normal calves; whereas, the original herd aborted or produced dead calves or calves that lived only a few hours. A large percentage of this first crop of calves was blind, contained soft bones, and showed edema.

This year's ration of cottonseed meal was supplemented with alfalfa meal and calcium carbonate.

This work is being conducted on the Central Experiment Station Farm and in the laboratory. During the past year the laboratory work has consisted largely in handling the record work in connection with the records of the Central Farm herd.

II. *Onion Flavor.*

The work with onion flavored milk was not taken up in the laboratory due to an insufficient milk supply. The only phase of this work undertaken during the last year was the feeding of Mrs. Lea's Milk and Butter Purifier, which was continued during a period of several weeks. In this test the results claimed for this material by the manufacturers could not be entirely corroborated.

COASTAL PLAINS STATION

III. *Herd Development Work.*

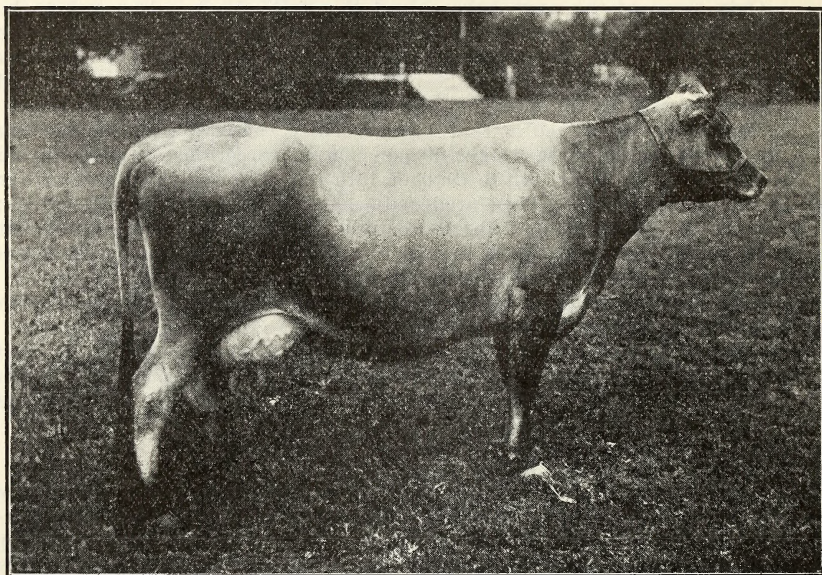
The herd on this farm consists of 34 animals divided as follows: 14 cows in milk, 15 bred heifers and calves, one Sr. herd sire, one Jr. herd sire, and 3 male calves. During the past year this herd was divided, 19 females being shipped to the Mountain Branch Experimental Farm at Swannanoa. The loss of these animals interferes somewhat with our record and herd development work.

The daughters of Eminent 19th, of which the herd is largely comprised, show an average of more than 18 per cent increase in fat production over that of their dams. Many of these records were made with the first calf, whereas the records available for dams were all made as mature cows. The difference would be even greater if only the mature records of the daughters were considered in making a comparison. The State record for fat production over all breeds is still held by this herd.

A line-bred Jr. herd bull has been secured to which it is intended breeding the granddaughters of Eminent 19th. This young bull is out of a gold medal cow. She is sired by a gold medal sire and out of a Register of Merit cow with a good record. The sire of this young bull is The Distinguished Fern. His daughters are a fine looking bunch, and show a large capacity at the pail. His sire is Sensational Fern, and his dam

is Eminent's Distinction, a gold medal cow. So far as breeding is concerned, this bull should make a most excellent cross for the granddaughters of Eminent 19th.

Only a few of the granddaughters of Eminent 19th are now in milk. One is on official test at present and gives great promise of winning the American Jersey Cattle Club's silver medal. In general, they seem to be capable of even greater production than their dams sired by Eminent 19th.



Pender Eminent Lass E. from Coastal Plain Station, Willard, N. C. Record, 13,774 pounds of milk and 792.48 pounds of fat, Class AA. This makes her Grand Champion Fat Producing Cow of North Carolina over all breeds, and entitles her to the American Jersey Cattle Club's Gold Medal.

MILK AND FAT PRODUCTION

November 1, 1922, to October 31, 1923

<i>Month, 1922</i>	<i>No. Cows in Herd</i>	<i>Milk Production</i>	<i>Fat Production</i>
November	21	7,839.1	439.79
December	21	8,873.0	470.16
January (1923)	21	8,004.5	491.65
February	23	7,111.6	377.85
March	25	11,335.6	611.40
April	18	10,182.6	526.52
May	16	10,416.0	529.57
June	16	9,013.9	437.84
July	15	8,438.7	421.57
August	15	7,978.5	476.01
September	14	6,766.2	350.44
October	15	7,030.3	395.39
Totals.....	---	102,990.0	5,528.19
Averages	18%	5,628.0	302.1

INVENTORY VALUE OF ANIMALS

64 cattle, 1922 value.....	\$7,215.00
19 cattle, shipped to Swannanoa.....	1,845.00
Sales during year	1,535.00
Increased value of herd.....	1,445.00

In addition to sending approximately \$2,000 worth of cattle to the Mountain Test Farm during the last year, there has been sold \$1,535 worth of breeding animals elsewhere. The last animal sold was consigned to the State Sale held recently in Hickory. This cow sold for \$450. Only three other females in the sale brought more money.

STATE HOSPITAL, GOLDSBORO, N. C.

This herd consists of grade and registered Holsteins. Early in the year the herd was gone over carefully, all culls being sold or slaughtered. A new herd bull of De Kol breeding was purchased by Mr. Combs at the request of the authorities. His first calves are now coming on and appear to be good individuals.

In addition to purchasing the bull, eleven registered heifers were selected and shipped to the farm. This work is being done in connection with the Dairy Experimental Office for the purpose of helping the above institution to place its herd on an entirely satisfactory basis.

FIELD EXPERIMENTS

In certain instances assistance has been given to breeders throughout the State by helping them to cull their herds, select good bulls and increase the productivity of their herds in general. Much of the trouble is due to improper feeding and handling.

One of the outstanding pieces of work done was with the L. F. Uzzle herd of Wilson's Mills, this work having been discontinued after the herd was brought up to a state of profitable production. The situation in this particular case was remedied by changing from a ready mixed ration to a home mixed ration. A few months work placed this herd on a profitable basis and three of the cows that were officially tested broke State records during the year, one of which still holds.

MISCELLANEOUS WORK

The usual amount of routine work has been conducted by this office during the year. This consisted mainly of answering inquiries, conducting laboratory tests, attending meetings, and in certain instances advising on the location of dairy farms and equipping same.

BEEF CATTLE AND SHEEP RESEARCH

R. S. CURTIS, *in Charge*

I. Cottonseed Meal Investigations.

This project is in cooperation with the Office of Dairy Investigations and the Office of Animal Nutrition with Messrs. Combs and Halverson in charge. This work has been pursued actively during the past year, using various supplements to correct the cottonseed meal and hulls rations. These have consisted of casein, yeast, butterfat, codliver oil, steamed bone meal and precipitated chalk.

No deaths have occurred during the past year among the cows, neither has there been spasms or convulsions with cows receiving the supplemented rations. Two living calves have been produced and up to date are doing well. This work is developing in a very satisfactory way, indications pointing to some definitely established facts.

So far this work has been conducted entirely with dairy cattle and their offspring. Plans are now being made to add a new phase to the work by the feeding of beef calves on supplemented rations. This work will begin about January 1st.

II. *Sheep Projects.*

For the present the work with sheep on the Central Farm consists of parasite control. This is being done with a flock of purebred Shropshires, these being used in addition for grazing experiments. Good results have been secured with the blue stone treatment when given under proper conditions. This treatment is being used also in numerous flocks over the State with very satisfactory results.

The work with the crossbred Lincoln-Rambouillet flock has been temporarily discontinued. This work consisted of determining the amounts of cottonseed meal which could be fed to breeding ewes without injury. This work will be resumed when a physical location is acquired to properly conduct the work.

PIEDMONT BRANCH STATION

III. *Sheep Grazing Experiments.*

During the past two years arrangements for conducting the sheep work have been made much more satisfactory, owing largely to the setting aside of a definite amount of land for livestock work. In making this arrangement for the development of swine and sheep work largely the latter has profited materially. While nothing is in definite shape for a report at this time except for a commercial statement on the cost of maintaining the flock, some good data is being secured.

IV. *Cattle Grazing and Feeding Work on Gwyn Farm.*

This work was terminated on October 1, 1922, and the data from the last three years work is available for publication. Following the close of this work, six months work was conducted on the cost of cleaning, seeding, and bringing this mountain land to a profitable stage of pasture production. This data will soon be ready to publish and no doubt will be a valuable guide in helping farmers and stockmen to utilize what has formerly been unprofitable land.

This work was under the immediate charge of Mr. F. T. Peden, who resigned on April 1st to engage in commercial work, this action following the completion of the cattle grazing and feeding experiments which have been in progress for nine years.

V. *Office and Miscellaneous Duties.*

During the last two and one-half years the writer has had general charge of the work of the Animal Industry Division, thus making it impossible to devote as much time to Experiment Station work as formerly. However, the main projects have been continued.

Considerable time has been devoted to organizational work with the group workers, both in the office and in the field. Along with this, the regular routine work of the Animal Industry Division has been conducted.

VI. *Meetings Attended and Duties Related Thereto.*

The chief meeting attended during the past year was that of the Southern Agricultural Workers at Memphis, Tenn. The writer was elected secretary of the Animal Husbandry section of this meeting and has just completed the preparation of the program for the next meeting, which is to be held at Birmingham, Ala., on January 10, 11, and 12, 1924.

VII. *Test Farms.*

All of the test farms have been visited during the past year for the purpose of keeping in touch with the several lines of work being conducted.

POULTRY RESEARCH

B. F. KAUPP, *in Charge*

Assistant: R. S. DEARSTYNE

I. *Septacacmic Diseases Among Fowls.*

Work is progressing very satisfactorily in regard to the comparative study of the various strains of the *Bacterium sanguinarium* (*Eberthella sanguinarium*). Strains were obtained for this comparative study from Pasteur Institute, Paris; Lister Institute, London; State Serum Laboratory, Rotterdam, Holland; Research Laboratories of Louvain University, Louvain, Belgium; University of California, and from twenty outbreaks in North Carolina.

We have shown definitely by these studies that Klein's disease of Europe is known under the name of fowl typhoid in America. During the year nineteen epidemics of fowl typhoid have been investigated. There have been vaccinated 2,140 birds, post mortem examination for diagnosis of the disease being done and the vaccine used being made in the Department Pathological Laboratory. Prior to vaccination the loss among these birds was 303 from this disease. Subsequent to vaccination the loss was 41, practically all birds lost having well defined fowl typhoid when vaccinated. Of 974 birds prophylactically vaccinated this year on infected premises, no losses occurred from this disease.

In this connection I might say that during the year there have passed through the hospital 193 birds, 41, or 21 per cent, of which recovered and were returned to their owners. Four hundred and forty-seven birds were received from over the State for post mortem examination from 124 sources, possibly representing 15,000 bird population. Such birds received were completely examined, organisms cultured for contagious diseases, such pathological examination of tissues as deemed necessary for diagnosis made. Examination for internal and external parasites is carried out, and complete report forwarded to the owner as soon as available with suggestions for correcting the trouble.

II. *Inheritance in Egg Production Studies.*

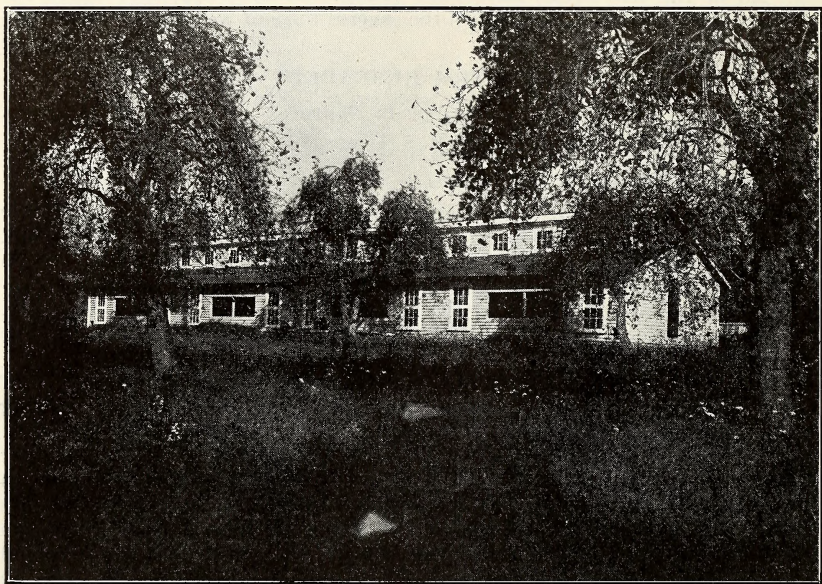
This is being carried on with Single Comb White Leghorns, Barred Plymouth Rocks, and White Wyandottes, confirming our previous statements that high egg production is transmitted from sire to daughter, and also from sire to son and son to daughter. Our previous report on this work has been reproduced in the Spanish poultry paper—"Mundo Avicola"—published by Sr. Castello at Barcelona, Spain.

III. *Feeding Experiments.*

Some of the experiments now under way in feeding lines at the various plants are dried buttermilk against normal liquid buttermilk, and also

against condensed buttermilk. Our studies indicate that as good results are obtained from dried buttermilk as from either normal liquid buttermilk or condensed buttermilk. This does not indicate that the drying process has destroyed to an appreciable extent the fat soluble vitamins.

Another experiment is that of fish meal against meat meal in egg production, fattening work, and rearing. Fish meal is found to replace meat meal in these tests. Given in 20 per cent quantities, it does not impart a fishy flavor to eggs or the flesh of fattened fowls.



One of the 20x100 ft. half monitor laying and breeding houses at the Mountain Experiment Station poultry plant.

The study of animal proteins and vegetable proteins is still being made; also, mineral mixtures to supplement vegetable proteins are still being studied. In our laboratory studies we found that our grains and mill by-products were short in four minerals; namely, calcium, sodium, chlorine and phosphate. Our mineral mixture studies during the past summer have shown that those birds which were given one-half per cent table salt and four per cent bone meal grew slightly larger, were slightly larger boned, and slightly more vigorous than those receiving the same feed without the mineral. These studies are made on Leghorns, Reds, and Buff Rocks.

IV. *Influence of Climatic Conditions on Egg Production and Development of Fowls.*

This coöperative study between the Manitoba Agricultural College at Winnipeg, Canada, and the North Carolina Experiment Station at State College, Raleigh, N. C., is now in its fifth year, and shows that a higher egg production is obtained at this latitude than at the latitude of Canada.

V. *Pathological Studies.*

An investigation into pathological conditions of fowls has been in progress and is a continuation of our previous work.

VI. *Parasitological Studies.*

A continuation has been made of the study of the prevalence of various parasites, their method of propagation and spread and means of control. We have found that round worms in the intestinal tract of the fowl can be effectively combatted with nicotine. At present we are recommending two per cent of powdered tobacco in the dry mash. Later on we expect to determine definitely the dosage of nicotine so that each bird can be individually medicated, we hope, with more certain favorable results.

In our routine autopsy work of dead birds sent to the laboratory from various sources we are finding that the gizzard worm, *spiroptera hamulosa*, is more prevalent than we had heretofore supposed. This worm burrows through the grinding part of the gizzard into the muscle walls.

VII. *Factors Which Influence Constitutional Vigor.*

A continued study has been made of the various factors which affect constitutional vigor and the reflection on the growing chicks and adults and the livability of their chicks. We have found that many flocks in this State are suffering from deficiency disease due to the fact that they are not receiving proper feed to furnish them proper mineral vitamins and proper proteins in addition to the fats and carbohydrates, and that the method of handling and unsanitary surroundings are partly the cause of some failures.

VIII. *Study of Anatomy and Physiology.*

We are continuing our physiological studies and studies of normal structure of the fowl that we may better understand the disease process.

IX. *Noncontagious Disease Studies.*

A study of the prevalence of noncontagious diseases and treatment and significance on production is being carefully studied in the laboratory and is being tabulated.

X. *Diarrhea of Chicks.*

Laboratory investigational studies of the various causes of diarrhea among chicks is being studied in connection with the study of septicaemic disease of fowls. We find very little disease due to bacterial infection, an occasional outbreak of coccidian diarrhea, but most of the cause of diarrhea is due to improper housing, handling, and feeding.

XI. *Effects of Shell Texture on Hatchability.*

In our studies on effect of shell texture upon hatchability of hen's eggs it was found that thin-shelled eggs were very low in hatchability. Next came ridged-shell eggs, followed by mottled-shelled eggs, with a very high hatchability of normal eggs. We do not recommend the setting of thin, ridged, or mottled shell eggs.

XII. *Effects of Artificial Lights on Egg Production and Growth.*

Studies have been continued on the effects of feeding hours on egg production and growth confirming our previous observations that spring production can be secured in the late fall and early winter by constantly increasing the number of feeding hours.

XIII. *Marketing Studies.*

In our marketing studies this year we have found that those birds and eggs sold on the local market bring more net returns to the producer than when shipped to the northern markets.

XIV. *Report of Publications.*

Among the publications is a preliminary report appearing in the Journal of the American Veterinary Medical Association in August giving the results of our studies of the normal temperature of the adult domestic fowl. It is found that the normal temperature is 107.3.

In *Poultry Science* in the October-November issue there appears a preliminary report on Digestible Nutrients of Poultry Feeds as Determined by Laboratory Feeding Tests. This gives our results of 101 individual digestion trials with poultry feeds and covers twenty different feeds.

The results of our studies on Respiration of the Fowl appeared in *Veterinary Medicine*, published in Chicago. The kymographic tracings were shown of the studies of the respiratory movements of chickens, turkeys, ducks, and geese. The average number of respirations in the male fowl is 20 and in the hen 36.

The Cost of Hatching Baby Chicks appeared in *Poultry Science*, giving the results of 52 sitting hens and 20 incubators. In hatching by hens in one series of experiments there was a hatch of 73 per cent, and in the second 70 per cent of all eggs put under them, while the average hatch in incubators was only 54 per cent.

There appeared in the *Journal of Agricultural Research* our results of studies of Time Required for Food to Pass Through the Intestinal Tract of the Fowl. It was found that digestion in the fowl was very rapid. In laying hens the food passed through the intestinal tract in three hours and fifty-two minutes, in growing birds in three hours and forty-six minutes, in hens not in laying condition in eight hours, and broody hens in eleven hours and forty-four minutes.

The Effects of Velvet Bean Meal Upon the Health of Fowls appeared in the January number of *Poultry Item*, which showed the result of six years tests in which 14 per cent, 28 per cent, or 45 per cent velvet bean meal or ground beans and pods are not suitable feed for growing birds and fattening fowls. Velvet bean meal in any form cannot be recommended for poultry feeding.

The Fate of Grit in the Gizzard of the Fowl occurred in the August number of *Poultry Item*. It shows that grit may be retained in the gizzard of the fowl for 365 days in sufficient quantities to grind the food.

A paper has been offered to the second World's Poultry Congress on our studies of digestibility of poultry feeds with poultry. This has been accepted by the central council and is being published with the balance of the papers to be presented at the second World's Poultry Congress to be held at Barcelona, Spain, May, 1924.

XV. *Reprints from Laboratory.*

There have been published 96 articles, including technical and semi-technical articles and popular articles for scientific publication, bulletins, circulars, poultry and farm papers, *Extension Farm News*, etc. One of these articles also appeared in the Journal of the American Veterinary Medical Association.

XVI. *Poultry Clinics.*

Dr. Kaupp conducted a poultry section of the clinic of the American Veterinary Medical Association during its meeting in August. There was also given an educational exhibit in connection with the State Fair and the Department conducted a poultry section of the Farm Life School Livestock and Poultry Judging Contest. Of 83 birds entered in the State Fair, 67 won ribbons, which makes 79 per cent. During the year there have been assisted in giving information either from telephone calls or visits to the plant and laboratory 325 people.

XVII. *Lessons in Caponizing.*

There was a lesson given in caponizing before the Farmers' Convention, also educational programs put on at the farmers' picnics at the Mountain Branch Experiment Station at Swannanoa and at the Coastal Plains Branch Experiment Station at Willard. There were twelve other demonstrations, such as culling, caponizing, and disease control work given to groups of people during the year. Some of these included judging at county fairs, in which we were assisted by senior students of the Department.

XVIII. *Meetings Attended.*

Dr. Kaupp also attended the meeting of the American Association of Instructors and Investigators in Poultry Husbandry, presenting a paper from the Research Laboratory. He was elected first vice-president of the association, also a member of the International Council, which has the staging of the World's Poultry Congresses, and a member of the International Committee on Publications. The next annual meeting is to be held at State College, Raleigh, N. C.

XIX. *Diseases and Disease Control.*

Talks on poultry disease and disease control were also made before the Southeastern States Veterinary Medical Association, held at Greensboro, N. C., in November, also before the Dixie Veterinary Medical Association, held in October at Memphis, Tenn., also before the county agents during the month of September at Clemson College, S. C., and before the North Carolina Poultry Association.

XX. *Miscellaneous Work.*

During the year just closed there have been written 3,300 letters giving information to poultrymen in regard to disease and disease control work, poultry house construction, feeding, rearing, incubation and other problems. There were 76 circular letters issued to county agents enlisting their support in our disease research studies, especially in regard to fowl typhoid. There were 506 other circular letters issued and 56 circular letters issued to the Farm Life School teachers similar to those sent out to county agents, making a total of 638 circular letters.

SUMMARY

One of the outstanding improvements in the work conducted by the various men of the Experiment Station group is the elimination of the lesser important phases of experimental work, which in reality should be classed as demonstration or test work. Practically all problems under way now are of a purely research nature, and these problems are almost without exception of south-wide, and in many cases nation-wide importance. The writer feels that this is a long step in the transition stage of placing this work in its correct position before scientists and workers of other states. Not until this is done will our work command the notice which it deserves.

The chief need of the Experiment Station group of workers is a better equipped place for doing their work. This will doubtless come as the work grows, but I feel it of such importance that this report should not be submitted without making mention of the fact. A closer touch is

needed, not only in the Experiment Station, but in the other fundamental phases of Animal Industry activities.

I would not feel justified in submitting this report without making mention of the splendid coöperation effective among all members of the division during the past year. The fact that all workers are continuing their problems not only in a larger but a more comprehensive and satisfactory way, even in the face of some difficulty, especially as regards space and physical equipment is a great source of satisfaction.

Hoping you will call on me for additional information should it be needed in compiling your report.

Respectfully submitted,

R. S. CURTIS, .

Animal Industry Division.

REPORT OF DIVISION OF ENTOMOLOGY

To the Director:—I present the following report on operations under my charge in investigation in entomology for the year 1923.

The pressure of the boll-weevil problem and the invasion of the State by the Mexican Bean-beetle has caused us to give much attention to these two insects during the year. Some of the other projects have been continued with accumulation of data for another year, while in still others there has been no occasion or opportunity for further work during the year. Each of our present projects is mentioned below.

INVESTIGATIONS

No. 1. Pecan Insects.—Dr. R. W. Leiby has carried this project for a number of years. The chief points in life-history and control of our most important pecan insects have been worked out. These findings are constantly used in advising growers, but no publication on the subject has yet been issued. Little was done on this project during the year.

No. 2. Larger Corn Stalk-Borer.—After several years work on this insect by Dr. Leiby the results were published in Bulletin N. C. Dept. Agriculture, August, 1920 (Vol. 41, No. 13, whole No. 274), "The Larger Corn Stalk-borer in North Carolina," by R. W. Leiby. This is a large and complete account. A more condensed Extension Circular on the subject is contemplated. This insect is complained of by farmers and county agents almost every year.

No. 3. Potato Spraying and Flea-Beetle Control.—The series of tests under this project has now extended through ten years, data and records for another year being added in 1923. The work has been done chiefly at the Mountain Branch Station, Swannanoa, N. C., by Dr. R. W. Leiby with the cooperation of Mr. S. C. Clapp, superintendent of the branch station.

The results have been published in Bulletin N. C. Dept. Agriculture, March, 1919 (Vol. 40, No. 3, whole No. 254), "Spraying of Irish Potatoes," by R. W. Leiby. Also N. C. Agricultural Extension Circular No. 103, "Spraying Irish Potatoes," by R. W. Leiby, issued March, 1920.

No. 4. Laundry Soap in Water for Aphids.—This has been a minor project, with miscellaneous tests in several different years, by Franklin Sherman. Owing to the fact that the commercial aphid remedies are not available in all localities and the difficulty and uncertainties in preparation of the old-time kerosene emulsion, we felt the need of a simpler remedy for aphids in gardens, flower beds, etc. We have abundantly satisfied ourselves that at rate of one pound to four gallons water, used as a spray, this is effective for cabbage aphid, rose aphid and other annoying species without the addition of oil, tobacco or other ingre-

dients. Its simplicity appeals. No special publication on the subject has been issued, but the findings are the basis of our recommendations, given many times each year. No new work on this in 1923.

No. 5. Insect Survey of North Carolina.—This project was begun by Franklin Sherman in 1900 and has continued ever since. Mr. C. S. Brimley was especially assigned to it in 1919, and has been with it since that time. All other members of the force, and others also, have made contributions to the collections and records. Mr. T. B. Mitchell and Mr. J. C. Crawford (of the force) are contributing much at the present time.

The aim of this project is chiefly threefold: (1) To list all species of insects occurring within the State; (2) to map the geographical distribution of each species in the State; (3) to record the seasonal occurrence of each species. Incidentally, much brief data on life-histories, food plants, parasitism, etc., is recorded. Thus this "Insect Survey" is intended to, and does, serve as a starting point for more elaborate studies of a species or group which may be needed.

From November, 1922, to November 1, 1923, a total of 232 species of insects was added to our lists, bringing the total now on record for the State to (about) 6,576 on November 1, 1923.

Numerous brief papers from this project have been published, many mentioned in previous reports. The following have been published during the past year:

"List of Robber Flies (*Asilidae*, *Diptera*) of North Carolina," by C. S. Brimley, *Entomological News*, Vol. 33, pp. 294-298 (December, 1922).

"Additional Records of Lepidoptera from North Carolina. *Papilionidae* to *Noctuidae*," by C. S. Brimley, *Entomological News*, Vol. 34, pp. 113-118 (April, 1923).

"Additional Syrphidae (*Diptera*) from North Carolina, with descriptions of two supposed new species," by C. S. Brimley, *Entomological News*, Vol. 34, pp. 277-279.

*No. 6. Black Corn Weevil (*Calandra oryzae*).*—The object of this study has been to observe field and storage conditions of infestation, as many farms have not storage places which can be effectively fumigated. Mr. T. B. Mitchell has been carrying on these studies during the year. Mr. Mitchell finds that early planted corn is likely to be more infested than that which is planted later. This gives a hint for avoiding the trouble, and also points to the possible uses (if care be used) of early planted corn as a trap crop to protect the later plantings. Old bins, if not thoroughly cleaned, promote infestation of new corn when stored in them.

Complaints of weevils in corn (chiefly this species) have been especially numerous during the past three years. The construction of *tight* storage places where the grain may be effectively fumigated may well engage the thought of county agents and the more interested farmers.

No. 7. Cabbage and Collard Dusting for Worms.—As result of the work in previous years there has been published during this year N. C. Agricultural Extension Circular 135, "Dusting of Cabbage and Collards to Control Worms" (January, 1923), by R. W. Leiby and S. C. Clapp. Effective control was secured by dusting approximately every ten days (during the period of worst injury) with a mixture of one pound powdered lead arsenate with six pounds of powdered (air-slaked) lime.

While we have not yet made adequate careful tests of the more recent material, calcium arsenate, yet the following experience may be noted. During 1923, while working at Bryson City, Mr. J. C. Crawford of this division found cabbages of Dr. Bennett to be badly infested with worms (involving several species); one dusting treatment was given of a mixture in the proportions of one pound calcium arsenate to one pound sulphur and four pounds lime. The treatment seemed to be entirely effective. A count before the treatment showed an average of not less than twenty-one worms per plant.

No. 8. Green Clover Worm.—There has been no severe outbreak of this insect since the overwhelming epidemic of 1919, hence there has been no new work. As result of the work of 1919, the following was published: N. C. Agricultural Extension Circular 105, "Green Clover Worm as a Pest of Soybeans," by F. Sherman and R. W. Leiby, July, 1920.

No. 9. Army Worms (two species).—There have been no opportunities for fresh work on this project during the year under review. It has been reviewed in previous reports.

No. 10. Mosquitoes and Control.—No noteworthy new work has been done on this project during the year.

No. 11. Cutworms.—Little work has been done on this project during the year. As a brief review of previous findings it may be said that the adult moths of certain species are easily attracted to bait traps, but *Feltia gladiaria* seems not to be especially attracted to them. On the other hand the pupæ of this same species seem to be easily killed by any disturbance of the soil (as by cultivation) during its summer pupating period. Considerable general data has been accumulated as to the biology of our several commonest species of cutworms.

No. 12. Cotton Boll Weevil.—During the year Dr. R. W. Leiby and Mr. J. A. Harris conducted special investigations of this insect in Moore and Hoke counties in the general region of Aberdeen where a field station was established. Each state has found it desirable to conduct fresh studies and tests regarding this pest, to work out the adaptations and modifications of what is already known from work by State and Federal workers to the southward. Growers desire this.

As it is intended to publish the results of these studies during the coming winter only a brief digest will be given here.

Dr. Leiby and Mr. Harris found that weevils emerged from hibernation during the latter half of May and the emergence continued until

approximately June 25. Egg-laying began June 19. Eggs hatched (midsummer) in three days, doubtless requiring longer in cooler weather. The larva, or grub-stage in the square or boll, required about ten days. Four days were required for the pupal stage. When the pupa had developed to adult it yet remained two days longer to harden before emerging. Summer-bred weevils lived an average of about fifty days—much variation in this of course. The unusual heat and dryness up to July 10 or later greatly retarded the early summer increase of the weevil.

During 1922 F. Sherman reared two species of parasites of the boll weevil from cotton squares in Anson County. During 1923 Dr. Leiby and Mr. Harris reared the same two species at Aberdeen, and two more in addition. This is interesting as showing that Nature has set her forces to work in our behalf, but no one should have exaggerated hopes of these natural enemies. We hope to gain further information in this field.

Tests by Messrs. Leiby and Harris of the standard dust-poison method of control gave substantial profit from its use, yet emphasized the advantage of the farmer knowing when to begin the dusting, which is amply explained in publications. On this particular point there was issued during the year N. C. Agricultural Extension Circular No. 137, "Dust-poison Method for Control of Boll Weevil," by F. Sherman and W. B. Mabee, July, 1923. This was based on our 1922 experience with this method, which was first developed at the Delta Laboratory of the Bureau Entomology, U. S. Department Agriculture at Tallulah, La.

Cage tests by Messrs. Leiby and Harris of a mixture of calcium arsenate and molasses applied early in season before squares had formed, did show that it would kill many over-wintered weevils before they had laid their eggs, yet when followed through the season in field tests the use of this mixture did not show a clear profit. There remains the possibility that its use may be advisable before squares are formed.

There was also a test of the "Florida Method."

The spread of the weevil through the State has been accurately determined year by year. The spread of 1922 covered almost the last of our cotton-growing territory. During 1923 specimens were received from correspondents in the most outlying cotton sections (counties of Currituck and Caswell), and the writer (Sherman) found it in a garden row of cotton in southern part of our extreme southwestern mountain county of Cherokee. No scouting was necessary in 1923. The boll weevil now (November, 1923) is in all of the cotton-growing area of North Carolina.

No. 13. Household Insects.—This minor project was carried by Mr. V. R. Haber, who resigned March, 1922, and has been inactive since that time. Considerable data and notes were accumulated.

No. 14. Peach and Plum Curculio.—The work on this project has been conducted at a field station at Aberdeen during 1922 and 1923. In 1922 the workers were Dr. R. W. Leiby of this Division, and Mr.

John B. Gill of the U. S. Bureau Entomology. After the season of 1922 Mr. Gill was transferred to other work, and Mr. J. A. Harris of our Division worked with Dr. Leiby during 1923. The work quickly assumed the proportions of a campaign, investigation and extension work going hand in hand, the fruit-growers basing their operations on the findings as announced from the station. The work was highly satisfactory both in 1922 and 1923. Some details were given in preceding report, and during the year the following has been published:

"The Plum Curculio on Peaches in North Carolina—Its Life-history and Control," by R. W. Leiby and John B. Gill (U. S. Bureau Entomology); Bulletin of N. C. State Department Agriculture, published for Agricultural Experiment Station March, 1923.

No. 15. Fall Canker-Worm in Mountain Forests.—During the period 1917 to 1920, inclusive, there were epidemic local outbreaks of Fall Canker-worm in some eight or ten mountain counties. Special studies were undertaken in 1920 by Mr. F. Sherman. The first examinations quickly showed that for the most part artificial control was impracticable in the wild, rough and rugged areas involved; even air-plane dusting, which we thought of and which has (then or since) been developed in Ohio, was not regarded as feasible, safe, or profitable in those mountain areas.

The study was therefore concentrated upon the general course of the outbreak and the natural enemies of the canker-worms. Birds, predaceous insects, and parasites were noted—an egg-parasite was found to be especially numerous and helpful. These natural enemies did give some evidence of "mobilizing," as it were, for attack on the worms. There was evidence that the outbreak was not as bad in 1920 as it had been in the several preceding years, and the indications were for further subsidence. This proved true. Except for one report in 1923, there has been no further report of epidemic damage by this species. The chief findings were recorded in a paper published in the Journal of Economic Entomology. No State publication on it has been issued. In 1921 two small lots of European Ground-beetle *Calosoma sycophants* were secured from the U. S. Gypsy Moth Laboratory at Melrose Highlands, Mass. These were liberated in an infected area on Grandfather Mountain. A brief search in the summer of 1922 failed to reveal survivors or progeny.

No. 16. Control of Peach Borer.—Tests and observations with the paradichloro-benzene method have been made, but the work has not been extensive enough to report fully.

No. 17. Parasites of Hessian Fly.—The work on this subject has been of a biological nature, and is carried by Dr. R. W. Leiby. The following paper has been published during the year:

"The Twinning and Monembryonic Development of *Platygaster hie-malis*, a Parasite of the Hessian Fly," by R. W. Leiby and C. C. Hill

(Bur. Ent., U. S. Dept. Agr.), in Journal of Agricultural Research, Vol. 25, No. 8 (August, 1923).

No. 18. *Mexican Bean-Beetle* (*Epilachna corrupta*).—Work on this project was conducted during the year by Mr. J. C. Crawford at a field station at Bryson City in Swain County. In this case, as with boll weevil, the general life and habits of the insect have been worked out to the southward, notably in Alabama, yet the demand is keen for fresh work in our own State.

As it is intended to report the findings in circular or bulletin form during the winter only a brief account is given here.

Mr. Crawford found that beetles began to appear in gardens last week in May, the majority coming out during first week of June. The eggs laid by these over-wintered beetles hatched after about 7 days—the grub (larva) feeding on the leaves required 22 days to become grown—the pupal stage lasted approximately 7 days—and the resulting generation of adult beetles was in full force by the second week in July. The second and third generations required less time, reaching the “crest” of abundance about August 5th to 10th, and September 5th to 10th, respectively. There was practically no fourth generation, though Mr. Crawford would expect it at Bryson City under normal weather conditions. It is believed that freezes May 9th and 10th with heavy early summer rainfall retarded their development.

During the time when each generation of larvæ was nearly grown, and while the resulting adults were young and voracious, there was heavy destruction of bean foliage, this occurring three times as above indicated. The damage to lima beans was practically as great as to string beans. The forage types of beans suffered comparatively little.

Accepting the recommendations of Federal and State workers to the southward as to calcium arsenate, and making tests of arsenate of lead because it is already better known in our mountain region, Mr. Crawford tested the following combinations for control:

Dusts (by weight): (1) Poison 1 part, lime 9 parts. (2) Poison 1 part, sulphur 1 part, lime 4 parts.

Spray: Poison 2 lbs. to water 50 gallons.

There was little difference in the effectiveness of the poisons against the insects, but the arsenate of lead at times caused severe burning of the plants (which was expected) for which reason its use is not recommended. The year's experience tends to indicate that it is easier to apply the remedy in dust form. Successful poisoning of the pole varieties was the more difficult, especially when planted among corn. The use of the “bush” varieties therefore gives better chance for the control of this insect.

Scouting work by Messrs. Mitchell and Harris toward the close of the season showed a considerable spread of the Mexican Bean-beetle to the

eastward—the line running through central parts of the counties of Ashe, Watauga, Avery, to central McDowell—thence eastward across southern Burke, then southward across central Lincoln and central Gaston. The region west of such a line is now occupied by the Mexican Bean-beetle.

In concluding this discussion of the investigation phases of our work, I wish to say that we feel obliged to give emphasis to the most immediate and pressing projects. For the past two years there have been boll weevil and curculio—now the Mexican bean-beetle claims attention—and always there stands the Insect Survey project with its accumulation of data on occurrence and distribution of numerous species of insects, as a basis for further inquiry into any desired group. The projects on Larger Corn Stalk-borer, Potato Spraying and Pecan Insects, are already covered by publications or far advanced toward general completion.

Respectfully submitted,

FRANKLIN SHERMAN,
Chief in Entomology.

Report of the Entomologist

To the Director.—The time of the entomologist is devoted chiefly to one project, the study of the leafhoppers. Some little time, however, is devoted to two other projects, one dealing with the corn root worm and the other with the corn-ear worm.

Leafhopper Project.—During the past year we have spent about half of our time on a review of the planthoppers of Eastern North America, and the results have been published in an abbreviated form in the Journal of the Elisha Mitchell Society, Vol. 38, pp. 139-230, together with three colored plates and thirty black and white plates. This is the first time that this group of insects from Eastern North America has been dealt with in a systematic manner, and the results accomplished will make it possible for other workers to identify insects in this group in a satisfactory manner.

Considerable time has also been devoted to a study of the morphology of the leafhoppers, for without a sound base in morphology it is impossible to work in a satisfactory manner on the economics or on any of the other problems. Most of this work has been done at the Bussey Institution for Biological Research of Harvard University, where we have had placed at our disposal the laboratories and other facilities of the institution. Two papers dealing with two different phases of this problem are now being written and should be published some time during the coming year.

The index to the literature of the Homoptera is progressing in a satisfactory manner and now consists of about 120,000 references. Your entomologist has been appointed one of an editorial board of five to prepare a catalogue of the Hemiptera of the World, and it is hoped

that this index can be completed some time during the coming year so that it may be ready for publication by 1925.

Considerable work was done this past spring in the study of the feeding punctures of the common species of leafhoppers on various plants. Leafhoppers are responsible for a wide variety of leaf spots on common plants. It is our purpose to determine the type of leaf spots caused by our common species of leafhoppers on all the different plants on which they feed.

Corn Root Worm.—Our studies of the effects of the time of planting on the damage caused by corn root worm have been continued at Wenona and Willard. These experiments must be continued over a long series of years in order to eliminate local variations due to climate.

Observations have been made this past season on the effects of planting corn continuously as against three-year rotations, and the results are so striking as to lead one to believe that proper rotation may be a solution of the corn root worm problem in the eastern part of the State. At Willard in the field where corn was planted in a three-year rotation the root worm damaged only 10.7 per cent. In new ground which was planted to corn for the first time, the damage was 29.3 per cent. In the field where corn had been grown continuously for three years the damage was 43 per cent. It is planned to continue these experiments another year to determine whether these results will hold good over a series of years.

The fact that striking differences in the amount of damage caused by the root worm may be noted in fields which have been properly rotated as indicated above, leads us to believe that there must be something besides the mere rotation which causes such striking differences. The most plausible explanation would seem to be that there is some residual fertilizer element which remains in the soil and acts as a repellant to this insect. We have attempted, therefore, to study soil repellants, but much more work must be done before a satisfactory soil repellant is found for this insect.

Corn Ear Worm.—In connection with the time of planting the experiments with corn root worm we have continued our observations on the effects of the time of planting on the damage caused by the corn ear worm. Our observations for the past three years indicate that there is a direct correlation between the time of planting and the damage caused by the corn ear worm. Certain other observations have been made on the varietal resistance to the corn ear worm. Observations, of course, must be continued over a long series of years, but the present indications are that a proper combination of time of planting with resistant varieties would very materially reduce the damage caused by this insect.

Respectfully submitted,

Z. P. METCALF,
Entomologist.

REPORT OF DIVISION OF HORTICULTURE

To the Director:—I herewith submit the report of the experimental work of the Division of Horticulture for the fiscal year ending June 30, 1923:

GENERAL

The experimental work of the Division is being continued along the lines of the projects described in previous reports.

The greatest interest in both commercial and home horticulture that has ever existed in the State has resulted from the operation of existing agricultural conditions and conditions in different horticultural industries which include the general economic need for diversification, boll weevil conditions and a realization of advantages of the State for different horticultural crops. This great interest has resulted in increasing demands on the Division of Horticulture for service of an investigational nature.

Considerable attention has been given to a more thorough direction and organization of the work. The organization of investigation so that direct attention to problems of outstanding importance may be developed has been borne in mind. Every attempt is being made to develop a program of work which will contain live projects definitely adapted to fundamental and special problems of the State. The projects are being organized so that problems of first importance will be selected and so that the expenditure of funds and energy on problems of only local application will be limited. Every project is reviewed each year with a critical attitude to see if it is fulfilling the purpose for which it was intended.

In general, satisfactory progress should be reported in the experimental work with apples, peaches, pecans, sweet potatoes and Irish potatoes. Certain specific projects were discontinued temporarily because of the lack of funds to properly conduct them. Unfavorable weather in spring interfered with some of the fruit investigations.

From the standpoint of station work, chief mention should be made of projects in apple pruning, cultural practices, variety testing and seed development with Irish potatoes, cultural practices, seed selection, and storage investigation with sweet potatoes.

Pruning work with apples conducted at the Mountain Station is giving conclusive results in the value of training apple trees to the modified leader and the use of a light system of annual pruning. It has demonstrated further that the majority of our growers who do prune, cut their trees severely, with the result that fruit bearing surface is greatly reduced and the trees are much later in coming into bearing. While only four years results have been secured in this work it is clearly evident that the results are going to be worth thousands of dollars to apple growers.

The project of developing methods for producing seed Irish potatoes in the western part of the State that are superior or equal to Maine seed has given results that indicate that this is a practical proposition and opens up new possibilities in potato growing in western Carolina.

Investigations with improved cultural practices in growing sweet potatoes are showing the value of these practices in giving increased yields and at the same time more uniform potatoes. One of the big problems in the sweet potato industry is to secure strains which will produce a higher percentage of uniform sweet potatoes. Selection work in this connection, which has been conducted for the last eight years, is producing striking results. The main problem in connection with sweet potato storage has been very well worked out, but there are many minor problems which need to be solved, and which are receiving our attention at this time.

As a result of the investigational work with pecans it has been definitely proved that Schley, Stuart, Success, and Alley varieties are of immense value in eastern Carolina. A number of points in connection with the soil requirements and cultural practices of pecans have been worked out.

Preliminary investigation with winter injury of peaches which has been severe in the Sand Hills and eastern part of the State in the last few years has brought out many interesting facts and suggestions for future work in solving this problem.

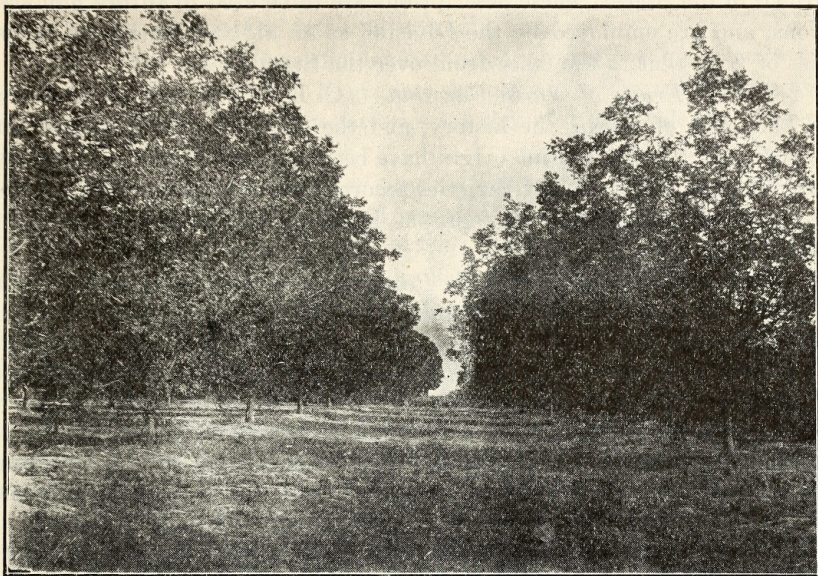
Several changes in the staff have occurred. The Division, as well as the State, experienced a severe loss in the death of Mr. L. H. Nelson, who was conducting the vegetable work. Mr. Nelson was one of the most valuable workers in the station. E. D. Bowditch, Assistant Horticulturist, resigned to become county agent in Mitchell County. He was succeeded by W. A. Radspinner. R. Schmidt was appointed to the position of Vegetable Culturist.

With the development of many new horticultural industries in North Carolina and with future progress in established industries, there is an increasing number of problems for investigation. To adequately cover the investigational field presented by the increase of horticultural industries it will be necessary for the Division to receive additional funds and to be provided with additional facilities to adequately conduct this work.

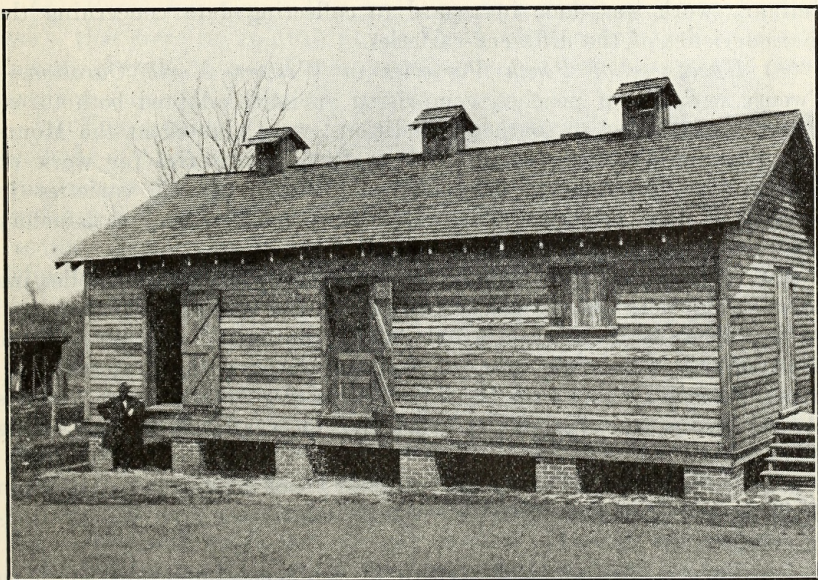
EXPERIMENTAL WORK IN POMOLOGY

1. *Variety Work in Pomology.* (C. D. Matthews and W. A. Radspinner.) Notes and observations on the behavior of varieties of fruits in the different sections of the State, are made from year to year. These notes and observations show the range of adaptability of the varieties in different sections.

Much time and care is expended each year in writing, revising and checking descriptions of almost all of the important varieties of fruit



Experimental Pecan Orchard, Stuart variety, trees thirteen years old.
Upper Coastal Plain Station.



This modern sweet potato storage house at the Upper Coastal Plain Station is divided into three sections for the purpose of conducting sweet potato storage tests.

grown in the State. These descriptions are to be used in future publications, and are employed by the Division as an aid in identifying varieties of fruit sent to the office from over the State.

2. *Native Fruits of North Carolina.* (C. D. Matthews.)

The place of origin, the history, and the description of a number of varieties of North Carolina origin have been secured. When opportunity offered, the descriptions of varieties secured previous to this season were verified. Paintings and photographs have been made of the most important varieties.

3. *Investigational Work with Peaches.* (Mountain Station, Truck Station, Piedmont Station, Coastal Plain Station. C. D. Matthews and W. A. Radspinner.)

(a) "*Dehorning*" *Peach Trees.* No active work done on this project during the year.

(b) *Peach Breeding.* It is the object of this project to produce improved commercial varieties that are more suited to North Carolina conditions than are the present varieties. It is the purpose to produce varieties hardier in bud than the present commercial sorts.

To provide working material for this project a variety orchard containing over 60 different varieties of peaches was planted at the Truck Station during 1917. These trees have made a very satisfactory growth since being planted. The last year nearly all varieties were killed by cold, and consequently no work was done. Some very valuable preliminary work was done in regard to collecting data concerning the characteristics of the different varieties.

(c) *Hardiness of Peach Varieties in Western North Carolina.*—Twenty varieties of peaches, comprising varieties adapted both to extreme northern and to southern conditions, were planted at the Mountain Station in the spring of 1919 to furnish material for work on determining the relative hardiness of different peach varieties in Western North Carolina. These trees have made a very satisfactory growth since being planted.

(d) *Phenological Studies with Peaches.*—The practice of collecting phenological notes on the peach varieties in the varietal peach orchard at the Truck Station was started during the spring of 1920. These notes will be of immense value in handling the breeding project.

(e) *Variety Testing with Peaches.*—No active work was done on this project because the crop at the Truck Station was killed by late spring frosts.

4. *Investigational Work with Pecans.*—(Truck Station, Coastal Plain Station, and Piedmont Station. C. D. Matthews and W. A. Radspinner.)

(a) *Variety Testing.*—Thirty-two of the most important southern varieties are included in this test which has been conducted for fifteen years. Gratifying results are being secured from this work, as certain

varieties are showing marked adaptability to North Carolina conditions, while others are proving to be undesirable.

At this time valuable recommendations regarding pecan varieties for planting in this State can be made. According to the results secured, the Schley, Stuart and Alley varieties are the most desirable for Eastern North Carolina.

(b) *Individual Tree Performance.*—The securing of performance records of the individual pecan trees in the experimental orchards at the several stations is being continued from year to year. Such a record affords a more detailed study of the behavior of the different varieties. As a result of the individual tree performance records, it has been noted that trees of the same variety under identical conditions are uniformly heavy yielders, while others are very poor producers; that some produce uniformly large nuts and others uniformly small nuts. As these individual performance records suggest the possibility of improving and standardizing individual yields by bud selection, work has been started along this line.

(c) *Cultural Practices.*—The value of correct cultural practices, such as tillage and the use of cover crops, is clearly shown in the increased size and number of nuts produced when compared to trees and their products grown in sod. To determine the most desirable system of tillage and cover cropping to be employed in pecan orchards, work of this nature is being conducted at the Branch Stations.

(d) *Pecan Breeding.*—The seedlings, as a result of pecan breeding work, that were set in 1915 at the Truck Station, are making a satisfactory growth. Some of these seedlings are of bearing size and should produce some nuts during the coming year.

(e) *Top-working Pecan Trees.*—The investigations dealing with the methods of budding and grafting employed in top-working pecan trees was continued this year. It has been found that a combination of both grafting and budding should be used to secure the most satisfactory results. As a result of years of investigation, it is the opinion of this Division that top-working should be confined, as a general rule, to trees not over 8 to 10 years old, to be entirely successful.

(f) *Cracking Tests with Pecan Varieties.*—The cracking test of the different varieties is made each year. The cracking test is a necessary adjunct to the performance record of a given variety in determining its value in a certain section. Very often a variety is highly satisfactory from a productive standpoint, but the cracking test shows it to be nearly worthless from a utility viewpoint. The cracking test shows the number of nuts per pound and determines the per cent of unbroken halves the variety will crack out, the per cent of shrunk kernels, the per cent of physiological spot, the per cent of faulty nuts, and shape and size of the kernels, the texture, quality and flavor of meat, the per cent of meat and the thickness of shell. As a result of these cracking tests,

certain varieties that were satisfactory from a productive standpoint proved to be totally unsuited to North Carolina conditions.

5. *Investigational Work with Strawberries*.—(Truck Station. C. D. Matthews and Robert Schmidt.)

(a) *Variety Testing*.—This project was discontinued temporarily because of lack of funds. The variety testing project with strawberries was initiated several years ago with the purpose of determining whether or not there were any other varieties more desirable as commercial market varieties than Klondike and Missionary, the two leading commercial varieties. For this State the most profitable berry combines the characteristics of productiveness, earliness, and shipping quality. None of the varieties so far tested have shown themselves superior to Klondike and Missionary as commercial varieties. Several of the varieties have shown themselves valuable for home use.

6. *Investigations with Apples*.—(C. D. Matthews and W. A. Radspinner, Mountain Station, Piedmont Station, and Truck Station.)

(a) *Pruning* (Mountain Station).—The pruning project was begun during 1919 with the intention of securing information on the desirable height to head apple trees, to determine the comparative value of the open head and the modified leader system of training, and to secure information on the amount of annual pruning most desirable. To supply material for this work, an orchard containing approximately 128 trees was planted at the Mountain Station in the spring of 1919. The trees have made a very satisfactory growth, and the first four years work has been completed as planned. The results so far secured indicate that growers have been pruning too severely, thereby causing a reduction in fruit production. Light pruning is the most satisfactory.

(b) *Apple Thinning* (Mountain Station and Piedmont Station).—Experiments to determine the effect of thinning fruits and leaves from the fruit spurs of the apple were initiated. Work on this project has not been conducted a sufficient length of time to supply information on the subject.

(c) *Summer Apples* (Truck Station).—The summer apple orchard at the Truck Station did not produce a crop this season because of frost injury.

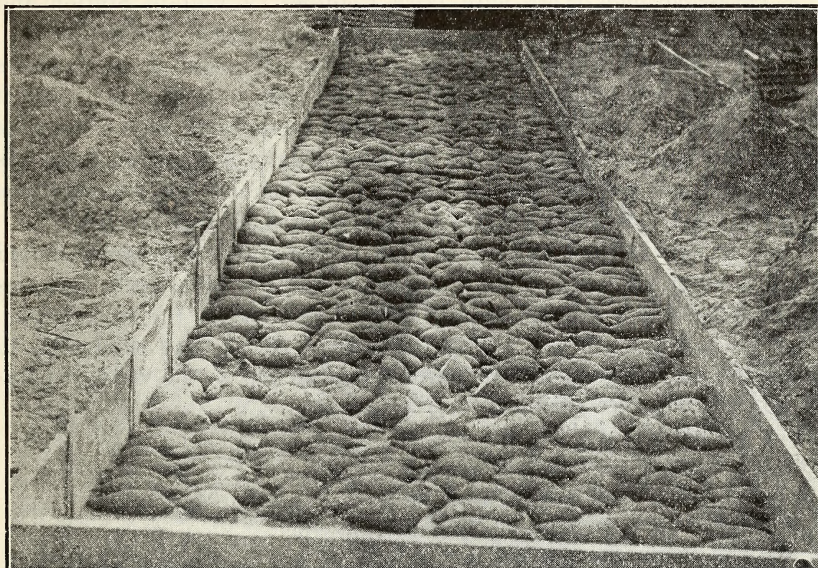
EXPERIMENTAL WORK IN VEGETABLE CULTURE

1. *Investigational Work with Sweet Potatoes* (Truck Station and Edgecombe Station, C. D. Matthews and Robert Schmidt).

(a) *Variety Testing*.—It is the purpose of this work to determine the most desirable varieties of sweet potatoes for Eastern North Carolina from the standpoint of productivity, quality, market value, and keeping quality. There were 29 varieties under observation this year. The results were, in the main, confirmatory of the work of previous seasons. Nancy Hall and Porto Rico have proved their desirability, while others have shown themselves to be undesirable.

(b) *Storage*.—In connection with the variety work, storage tests are being made from year to year in the storage houses to determine the behavior of the different varieties in storage. Certain varieties have proven themselves to be better keepers than others.

Investigations to determine the relation of time of digging to keeping quality, the relation of proper harvesting to keeping quality, the proper method of curing, and the correct management of the house, have been continued this season.



Treating and bedding sweet potatoes at Coastal Plain Station. Plants to be used in experimental work.

As a result of this work the Division can authoritatively make recommendations regarding varieties for storage and the most desirable methods to employ in the management of the storage house.

(c) *Cultural Practices*.—During the year work was conducted to secure information on the following different cultural practices:

- (1) The comparative value of slips vs. vine cuttings as regards productivity.
- (2) The effect of ridging on productivity and type of potatoes.
- (3) The effect of vine cuttings on yield.

(d) *Seed Selection*.—The following lines of work dealing with the seed selection of sweet potatoes were conducted during the year:

- (1) To determine the relative value of seed stock from high yielding and low yielding hills as regards productivity and uniformity of potatoes.

(2) To determine the relative value of vine cuttings as compared with slips for maintaining yield and type, commencing from the same hill.

(3) To determine the comparative value of large and small potatoes for seed.

(4) To determine the comparative value of seed from late vine cuttings and seed from main crop draws as regards productivity, type, and keeping quality.

Very satisfactory progress should be reported on this project for this year.

2. *Investigational Work with Irish Potatoes* (Mountain Station and Truck Station, C. D. Matthews, Robert Schmidt, and S. C. Clapp).

(a) *Variety Testing* (Mountain Station).—The testing of varieties of Irish potatoes to determine the most desirable varieties for western North Carolina conditions was discontinued temporarily this year. The testing has been in progress for a sufficient length of time to afford this Division the necessary information to make reliable recommendations regarding the choice of varieties for the western part of the State.

(b) *Variety Testing* (Truck Station).—Satisfactory progress should be reported on the work to determine the most desirable early varieties for Eastern North Carolina and the best varieties for the second crop.

(c) *Cultural Practices* (Truck Station).—Work was conducted to determine the effects of different cultural practices on the yield of potatoes. Practices receiving consideration were:

- (1) Width of rows.
- (2) Distance apart in the rows.
- (3) Freshly cut or stored cut seed.
- (4) Effect of sprouting on yield.
- (5) Cut versus uncut seed.

(d) *Testing the Value of Different Sources of Seed*.—Experiments were conducted to determine the comparative value of Maine grown seed, second crop seed produced in the Coastal Plain, and Western North Carolina seed in different stages of maturity as the most desirable seed for the early crop of Irish potatoes in eastern North Carolina.

Results so far secured indicate that this is a practical proposition and opens up new possibilities in potato growing in western North Carolina.

(e) *Investigation of Methods for Producing Seed Potatoes in Western North Carolina for Use in Eastern North Carolina*.—Two methods of attack are being used in this investigation—one consists in growing the seed at different elevations, while the other consists in planting the potatoes at different times in the spring and summer. In both cases it is intended to secure seed at different stages of maturity. At present results indicate that elevations over 2,500 feet will grow desirable seed for Eastern Carolina.

3. *Investigational Work with Cabbage* (Mountain Station, C. D. Matthews, Robert Schmidt, and S. C. Clapp).

(a) *Variety Testing*.—The testing of varieties of cabbage to determine the most desirable varieties for western North Carolina was continued this year. The testing has been in progress for a sufficient length of time to afford this Division the necessary information to make reliable recommendations regarding the choice of varieties for the western part of the State.

Respectfully submitted,

C. D. MATTHEWS,
Chief, Division of Horticulture.

LECOQ HERC NELSON

Our coworker, L. H. Nelson, has planted his last tree, has pruned his last vine and made his last study of fruits and vegetables for the North Carolina Experiment Station. On Thursday night, January 11, at Rex Hospital, in Raleigh, surrounded by members of his immediate family and his friends and coworkers, an Angel of the Lord relieved him of his sufferings and took his immortal soul back to the home awaiting its return. For over two weeks Mr. Nelson had suffered from complications resulting from influenza and pneumonia. Despite his serious condition, an effort was made to save his life by an operation. Weakened by sickness, it was impossible to save him, though he bore bravely this added pain without the kindly oblivion of an anæsthetic.

Valiantly he made the fight. Even his attending nurses, accustomed to scenes of pain, permitted their tears to run unchecked as they ministered to his needs. Finally he surrendered. His friends of the Experiment Station organization bore his body to its grave, and his casket, draped within the folds of "Old Glory," which he had served faithfully and well during the Great War, was lowered into the earth at Oakwood Cemetery in Raleigh. A volley was fired by members of the American Legion, and softly and sweetly the bugle call of "taps" echoed about the magnolias and pines, proclaiming the end of day for a soldier of his country.

He had been with us about four years, coming from the University of Kentucky, where he graduated with honors. He was a member of the Alpha Zeta fraternity, served in the war as a lieutenant in Field Artillery, and during his residence in Raleigh was a faithful member of the Vanguard Class of the First Presbyterian Church. In his work he was faithful and true, devoting himself conscientiously to a study of the horticultural problems of North Carolina. Though only a young man, he was rapidly building a reputation as one of the leading investigators along his chosen line. His loss will be keenly felt and his place hard to fill.

"Softly his fainting head he lay
Upon his Maker's breast;
His maker kiss'd his soul away,
And laid his flesh to rest."

REPORT OF THE DIVISION OF PLANT PATHOLOGY

To the Director:—The following statements constitute a report by projects of investigational work of this Division during the past year:

Tobacco Wildfire.—The studies on this disease have been concluded and the results published in Bulletin 246. This disease, which was first investigated by this Station in 1917, has spread to Virginia, South Carolina, Florida, Georgia, Tennessee, Kentucky, Pennsylvania, Ohio, Maryland, Vermont, Wisconsin and to certain sections in South Africa. All of the essential facts which have been learned in regard to the nature of wildfire, the conditions favoring its development and spread, and its control by means of seed treatment, together with the use of new plant bed cloths or sterilized old ones, and the employment of new plant beds or thoroughly fired old ones, have been confirmed by investigations at other places.

Soybean Diseases.—This project, which was confined originally to soybean bacterial blight, was modified in order to consider the relation of bacterial blight to an undescribed bacterial disease of clovers. The results of this portion of the work, conjointly with investigations on the same disease by Dr. L. R. Jones and Mrs. M. W. Williamson, University of Wisconsin, Madison, Wis., and Miss Lucia McCulloch, Bureau of Plant Industry, Washington, D. C., have been submitted for publication in the "Journal of Agricultural Research." This report shows that the bacterial organism causing a leafspot disease of red, white, alsike and other species of clover is distinct from both *Bact. glycineum* and *Bact. sojae* from soybean, and that the clover pathogen has not previously been described. The clover disease organism is shown to be seed-borne and to be introduced into new fields and new localities through the use of infected seed. This indicates that seed treatment must be employed should the disease become seriously destructive.

The investigations of pod and stem blight of soybean have been completed, and the results have been published. This disease, which has not been collected outside of the State, causes the premature death of plants, a failure of the young ovules to develop and a molding and decay of seeds in later stages of development. Leaves are also attacked and lesions appear on the leaf tips and margins. The causal organism appears as small black specks on affected parts. It has two stages, a conidial stage, *Phomopsis*, and an ascogenous stage, *Diaporthe*. The organism is hitherto undescribed and is given the name *Diaporthe sojae*. It over-winters on diseased stems and diseased seed. Not all varieties of soybeans are equally subject to this disease, but such early maturing varieties as the Black Eyebrow are most susceptible. The disease is most abundant during rainy seasons and is very scarce during dry seasons. Control depends on the use of such sanitary measures as the use of disease-free seed and crop rotation.

Attention has been directed during the past year to a downy mildew disease of soybeans which proves to be a new one for this crop. A complete report of this study has been prepared.

The investigation of two other soybean diseases, bacterial pustule spot, first reported by Hedges (Sc. n. s., vol. 56, 111-112, 1922), and brown spot, *Septoria glycines*, described first in 1915 in Japan, is in progress.

Strawberry Leafscorch.—This disease, although it was first recognized in the United States about forty years ago, was little known prior to the investigations at this station, a report of which is in press. Leafscorch was seriously destructive in the strawberry growing sections of North Carolina in 1922, as witnessed by the fact that an average loss of twenty per cent was sustained in Columbus County according to estimates furnished by about 200 growers.

Purplish to reddish lesions, which coalesce so as to involve the entire leaf surface and give the plants a dry, burned appearance, characterize this leafscorch disease. Affected plants may be very much weakened and as a result succumb during summer. The disease appears also on petioles, fruit pedicels and calyx lobes. The impairment of the fruit results largely from the infection of the calyx.

The studies on the life history of the causal organism show that it has two stages. The conidial stage is of the *Marsonia* type, with subcuticular acervuli. The ascigerous stage, which matures in spring on dead leaves, is not one of the disc fungi belonging to the *Pezizales*, as was hitherto believed, but one of the *Phacidiales*. Furthermore, it does not belong to the genus *Mollisia*, but to the genus *Diplocarpon*, and is, therefore, assigned the new name *Diplocarpon Earliana* (E. & E.).

The field trials during the past spring have given very satisfactory control, when destruction of the tops during June was followed by spraying at definite intervals during the following spring. Further field experiments are in progress.

Control of Seed-borne Infection.—It is deemed sufficient to state at this time that satisfactory progress has been made in these investigations, a considerable body of data has been secured and the results will be prepared for publication within the next year.

Aside from the work on these projects, experiments on control of two seriously destructive diseases have been initiated during the past summer. One of these diseases is "take all" of wheat, which was first found in the United States in 1920. During the past summer it has been collected in Lincoln, Cabarrus, Iredell, and Alexander counties. The experiments on the influence of crop rotation and tests of varietal resistance are being conducted in coöperation with the office of Cereal Disease Investigations of the U. S. Department of Agriculture. The other disease is anthracnose of dewberries, which is being investigated in coöperation with specialists in fruit diseases from the U. S. Department of Agriculture. It seems inevitable with the recent rapid increase in dewberry plantings

that diseases will be introduced and become the cause of considerable losses. Heretofore, dewberry growers have had little concern over diseases, but in a number of instances during the past year, decreases in yield from anthracnose have made dewberry culture unprofitable.

A qualitative method of greater delicacy than those previously known has been developed for the determination of pectin decomposition. Since the middle lamella of plant cells is composed of pectic substances, and since plant pathogens can penetrate the tissues only after having attacked these substances, this method is of value in studies of tissue changes induced by plant parasites.

Collections have been made of a number of diseases which appear to be worthy of mention, either because they are little known or entirely unknown in other states. These include a pepper-rot caused by a fungus of *Macrophoma*-like structure, a wilt of mung bean, *Phaseolus aureus*, caused by a species of *Fusarium* and a leafspot of this same host caused by *Amerosporium economicum*, which has hitherto been known on cowpea only.

The several detailed reports of the investigational work of this division which have been published or submitted for publication include the following:

1. Wildfire of Tobacco, N. C. Agricultural Experiment Station Bulletin 246: 4-27, figs. 7, 1922 (F. A. Wolf).
2. Studies on the Physiology of Plant Pathogenic Bacteria VII Pectic fermentation in Culture Media, Containing Pectin. *Phytopath* 13: No. 9, 381-384, 1923 (F. A. Wolf).
3. Noteworthy Plant Diseases in North Carolina in 1922, N. C. Agricultural Experiment Station Ann. Rept. 45: 74-76, 1923 (F. A. Wolf).
4. Bacterial Leafspot of Clovers, *Jour. Agr. Res.* (in press). (L. R. Jones, M. W. Williamson, F. A. Wolf, and Lucia McCulloch.)
5. Strawberry Leafscorch, *Jour. Eliha Mitchell Soc.* (in press). (F. A. Wolf.)
6. A New Downy Mildew on Soybeans, *Jour. Elisha Mitchell Soc.* (in press). (S. G. Lehman and F. A. Wolf.)
7. Pod and Stem Blight of Soybean. *Ann. Mo. Bot. Garden* 10: 111-178, figs. 13, Pls. 9-13, 1923. (S. G. Lehman.)

Respectfully submitted,

FREDERICK A. WOLF,
Plant Pathologist.

REPORT OF DIVISION OF MARKETS AND RURAL ORGANIZATION

To the Director:—This report is for the year ending December 1, 1923, and covers the investigational work of the Division of Markets and Rural Organization:

COTTON CLASSING

P. H. Hart, Specialist in Cotton Classing reports that during the past fiscal year ending December 1, 1923, his section had classed approximately 138,000 bales of cotton.

Since the organization of the North Carolina Coöperative Cotton Growers Association most of the cotton has been classed at the Raleigh office, where eight classers and five helpers are needed to keep up with the work during the rush season. Only two branch offices were opened this season at Fayetteville and New Bern. The office at Fayetteville was closed November 15th on account of the resignation of the classer, but the one at New Bern is still open.

The Fayetteville office reported 3,500 bales classed; the New Bern office approximately 2,500 bales. Of the total 138,000 bales practically 120,000 bales were classed for members of the Cotton Association.

LIVESTOCK MARKETING

The work in livestock marketing was almost at a standstill until the return of Mr. V. W. Lewis early in October. Since then there has been greatly increased activity and interest in this most important project.

As has been the case in the past, a great amount of time is given to farmers who are interested in locating or disposing of pure bred animals suitable for use as foundation stock in breeding herds.

Hogs.—The interest in coöperative marketing of hogs is still increasing. In fact we know of no farmers who have not been highly satisfied with the plan of preparing hogs for the high spring and summer markets. With the good corn crop we have this year and with corn reported as worth only 60c. on local markets, we are recommending feeding it to the pigs in order to push them for the March or early April market, rather than to carry them over for fattening next fall. Those pigs which cannot be fattened in time for the March market can be kept growing now and finished later for the next high point in the market, which usually comes in August. With all the natural advantages we have it seems folly for our farmers to attempt to compete with hogs from the middle west on the late fall and early winter markets.

Lambs.—For the past twenty years on the Chicago market lambs have brought most money per pound along in April. The corn-belt farmers, because of climatic conditions, cannot have their lambs ready in April. Eastern North Carolina farmers can, and yet with all the advantages

of climate that we have, very few lambs are dropped by January 1st, and by far the majority of them are born during March and April.

With the grazing we could have from rye and oats and cover crops, how much better it would be to have the lambs come in November. Then we could have them ready for the high prices which usually feature the April market. Advantages which should be considered are the most economic use of labor at this season, the control of stomach worms, and the higher prices—three very important factors.

Why should we attempt to follow the exact time and manner of livestock production as followed in the Middle West? Why not capitalize our own advantageous climatic conditions and surroundings to bring in greater returns from the same class of production by getting our products on the market when the producers of the Middle West cannot compete with us? We are stressing this point especially for Eastern North Carolina.

Wool.—Those counties which assembled their wool, carefully graded it, and held it for the better markets have been nicely rewarded. In recent sales Watauga County reports receiving for her wool a price of 50c. per pound on best grade of wool free from burs, while Pasquotank County sold at 45c. for the best grade. This office is always glad to assist with the grading or in locating buyers.

Cattle.—The coöperative cattle sale at Spruce Pine on October 10th was a pronounced success. The farmers seemed well satisfied with the returns from the 650 cattle sold at auction. This is the third sale held at Spruce Pine in this manner. We believe, however, that enough educational work has been given these people so that hereafter they will be able to conduct their own sales. In order that the deal may be even more satisfactory and business-like, the growers are now contemplating the use of a short-term contract binding them to market through the association and to produce their cattle in accordance with its regulations. This will insure a more uniform quality of cattle.

In connection with this we are also recommending the replacement of the scrub bulls with the best type of beef animals, and plans for the gradual grading up of the cattle of this section have been submitted to the members of this association.

Poultry and Eggs.—The coöperative marketing of eggs is one of the most recent projects. The first association, the Cleveland County Coöperative Egg Association, began business on January 1st with 5,500 hens contracted for one year. They are shipping 10 to 15 cases of eggs weekly. If this works out well the contract will be made on a five-year basis after this season and assistance will be offered to other important egg-producing counties.

There has been a great increase in the production of early broilers in several counties. These young broilers weighing about one and one-half pounds are ready by the middle of January and command fancy prices in the proper trade channels. If sold in the smaller places they will

hardly bring their worth. Usually the finer hotels offer a good market.

Prices on turkeys on the northern markets were best very early in the season and growers were encouraged to sell early. Some did, but many did not, and they were unable to find shipping to the northern markets at holiday prices a paying proposition. For these people it was necessary to find local markets, as these remained fairly steady throughout the season. One of the greatest drawbacks to our turkey business is neglect toward the fattening. Half-fattened birds are offered to the public at Thanksgiving, and this demoralizes our Christmas trade. More attention should be given to fattening if we are to build up a nice trade in turkeys. Market prices received daily over our leased wire were mailed regularly to interested parties during the turkey marketing season.

FRUITS AND VEGETABLES

The past season has been an unusually active one in the fruit and vegetable section. There has been particularly great increase in the interest in local inspection. In fact, in some cases it was not possible to secure really competent men to do work for which the communities were willing to pay so that they have had to wait for another season, hoping that the situation may be improved. Mr. G. Shumaker, of this project, reports that the man who markets poor quality produce or packs deceptively is being outlawed in a way by the great throng of enthusiastic growers who are determined to make the name "North Carolina" stand for something whenever it appears on a package.

REGULATORY AND POINT-OF-ORIGIN INSPECTION

Local inspection work of a regulatory nature has been continued as far as possible, but the great amount and variety of shipments makes our small force entirely inadequate. Continued improvement, however, is noted everywhere, but especially in the strawberry and potato sections.

In coöperation with the Federal Department of Agriculture we served our Sand Hill peach growers with State-Federal point-of-origin inspection for the first time this season. Practically every car shipped from this territory carried a State-Federal certificate, and the growers were much pleased with the benefits of this service, for they were provided with better refrigerator cars than heretofore, and not a single car was turned down by the purchasers when it arrived in the market.

This work with peaches practically paid for itself through the inspection fees collected. With a full crop it can be carried on with even a smaller fee than was charged this season.

Point-of-origin inspection will be stressed during the coming year as one of our major projects, as demands have already been received for this service in connection with strawberries, potatoes, apples and truck.

Federal Leased Wire News Service.—During the year the State Division of Markets was fortunate enough to secure the installation in its

offices of the leased wire telegraph service of the U. S. Department of Agriculture. The Raleigh office is on the Southern circuit, which also has drops from Washington, D. C., to Richmond, Atlanta, and Jacksonville.

All traffic is scheduled and controlled by the Washington office and is transmitted simultaneously to all the big market centers. During the night the Washington office receives hundreds of telegrams from railroads reporting the carload movement of perishable commodities over their respective divisions. These telegrams give the origin, destination, commodity, and number of carloads in transit. The information is classified and tabulated and moved to all offices early the next morning to show graphically the total value of perishable fruit and vegetable products moving to the various cities.

Following this information the estimated receipts at livestock markets are dispatched, followed by general reports on livestock, meat, and other products showing supply, demand, wholesale prices and conditions. Flashes on cattle, sheep and hogs are dispatched. Butter and egg quotations, and local quotations and information from the big markets on fruits and vegetables follow. During the day considerable general information on cold storage products, peanuts, honey, hay, grain, feed, butter, eggs, cheese, fruits, and vegetables moves over the circuits.

At the close of the day market summaries on all commodities are dispatched for release to newspapers and to radio, telephone or telegraph broadcasting stations. The information received over the wires at the various branch offices is available to producers and the trade by telephone, telegraph, radio, and the press so that almost at any moment farmers and the trade everywhere may have an accurate picture of the national agricultural market situation. Consuming centers are also advised as to the supplies of various products. This enables producers to regulate shipments so as to prevent the glutting or undersupplying of markets which, according to department officials, is the outstanding value of the service as the result is stabilization of prices to both producers and consumers.

Market News Service field stations were continued again this year, at Chadbourn for strawberries, and at Elizabeth City for potatoes.

Curb Markets.—Curb markets of the bazaar type have been featured particularly, and some twenty of these are now in active operation. Splendid reports received from them weekly form the basis for the Weekly Curb Market Report which is a resume of prices and conditions at the various marketing centers within the State.

ECONOMIC SURVEY OF CUMBERLAND COUNTY

During November plans were completed whereby representatives of the Federal Bureau of Economics assisted by State officials would conduct an economic survey of Cumberland County. The object of this

work is to inventory the production of agricultural commodities in Cumberland County and to obtain economic information which can be used in production and marketing extension work both locally and in other counties.

From the data secured it will be possible to recommend such steps as will tend to correlate local production and consumption with a view to capitalizing the natural advantage of the community.

Other counties have already made application for similar surveys.

AGRICULTURAL STATISTICS

The past year has resulted in better information than any previous year, according to Mr. Frank Parker, Agricultural Statistician. No particularly new work has begun. One feature was temporarily discontinued, that being the threshers' reports.

Crop Reports.—Due to the heavy and increased number of regular and special crop and livestock reports demanded, it was necessary to give more attention to maintaining the voluntary lists and to developing and interpreting the results. There were 54,823 total schedules for reports sent out during the year, 14,000 reports received. The total pieces of mail received were 22,214, and the total reports issued were 66,397 copies. The regular and special schedules carried a total of 888 items for the year.

Those were developed into county, district and State acreages. Most of the crop and livestock estimates are developed by weighed averages. Editing is essential, and requires a knowledge of current county factors for each subject. The press has called for and used all that we could get time to furnish in the way of newspaper stories. It was impossible to develop more than a small part of the information available into popularly interpreted information, as the Crop Reporting Service does not have a field statistical and economics specialist other than the Federal representative in charge.

Farm Census.—For the first time every county in the State made a creditable farm census survey report for 1923 crops. The enumerations were otherwise quite creditable. Sixty-eight counties made reports for every township, while only fourteen counties had more than one township survey lacking. Sixty per cent of the farm land area of the State was enumerated in the Farm Census Work, after editing out all unsatisfactory reports. There was less faulty work than previously. Far less objections and more favorable expression and evidences were noted. The county commissioners generally approved of and paid for the listing of the crop acreages.

The increased demand for and widespread commendation of the published results of the 1922 results were self-evident of the need for and value of this basic farm economics information. It was also evident that it is needful for safe buying and selling programs. With the increasing

degree of accuracy and practical nature of the results, there is reason to expect valuable interpretations of forecasts, trends of production and prices. When this is done, North Carolina will be another step ahead of other Southern States.

General.—The North Carolina work now covers almost all phases of farm statistics. The lists of voluntary reporters include the following: General (all crops, monthly), 1,700; cotton (monthly), 1,400; farm census (tax supervisors), 1,200; price, 450; tobacco, 500; threshermen, 1,800, and peanuts, fruit, truck, legumes, pecan, potatoes, livestock, county officials, storage houses and others which include less than 500 each. The greatest confidential information list is the farm census, which gives about 170,000 farm owners by townships, counties and detailed crops.

The need in this office is the practical development of economic information by a statistical specialist who would have no other duties to interrupt. The North Carolina farmers need to know the facts of what was done last year, as well as how they ought to do in 1924.

The only new plans contemplated are for a statistical economics laboratory in coöperation with the State College. If made effective, this will help to relieve the present greatest need for interpreted information.

CREDIT UNIONS

The credit unions of North Carolina have been more or less an experiment in the past, and have had only part time supervision. The success attained warrants their consideration as permanent institutions in this State. Mr. A. V. Anderson, Specialist in Rural Credits, will devote his full time to supervising credit unions and organizing new unions where there is a need for credit facilities.

There are at present twenty-six credit unions incorporated in this State. They are located in eleven counties in the various parts of the State, and are revealing the needs of the different types of farmers.

The credit unions have been handicapped in the past by not having a simple but adequate system of accounting. Such a system has been devised, and is now ready to be installed in all the unions. Monthly inspection of books will be made until the secretary-treasurers can handle them, and then inspection will be less often.

The credit unions in this State have performed a wonderful work in the communities in which they have been located. They have provided a means of saving and a system of legitimate credit resources. Savings collected are loaned to members for productive purposes. The money that has been out of circulation comes out from its hiding and commences to draw interest and to work for the benefit of the community. From this the members are learning the value of capital. They are becoming thrifty, and they are beginning to adopt business methods in

their farming operations which they are forced to use in the credit union. With this education in business and an object lesson in thrift, they get a new vision of life and realize it is possible for them to work out of their difficulties.

Five communities are now ready for the organization of credit unions.

Respectfully submitted,

B. F. BROWN,
Chief, Division of Markets.

REPORT ON DRAINAGE

To the Director:—I hereby submit the annual report on Drainage conducted under a coöperative agreement between the North Carolina Department of Agriculture and the United States Department of Agriculture. This report covers the crop year November 30, 1922 to November 30, 1923.

Mr. J. A. Brophy, who had been acting as Junior Drainage Engineer of the North Carolina Experiment Station, resigned on February 1, 1923. Mr. Alfred Ogram, Junior Drainage Engineer of the United States Department of Agriculture, was detailed to this State on March 26, 1923, but was recalled on May 19th. Since that time the writer has been carrying on the work without assistance.

On July 1, 1923, the work of the Drainage Division was placed on a research basis, and it is planned to carry on projects along experimental and research lines exclusively in the future. However, a large number of extension projects that had been approved remained uncompleted on July 1, and the time of the writer since that date has been devoted for the most part to clearing up these unfinished projects. This work has been conducted along the same lines as in previous years. In general, the extension part of our program consisted (1) in assisting farmers in the improvement by drainage and terracing of lands now under cultivation, and (2) in making preliminary and reconnaissance examinations for drainage districts desiring to make drainage improvements.

Upon request, either from the county agent, or the farmer, the Drainage Engineer made preliminary examinations, surveys, designs, estimates, specifications and reports for tile drainage projects on the farm. A blueprint was sent to the farmer, showing the complete system of drains. When the farmer was ready to install the tile, certain drains were staked out in the field and instructions given in the proper methods of construction.

Terraces were laid off in entire fields, and instructions given in the use of the farm level, and in terrace construction. Various methods of construction were demonstrated at terrace building demonstrations, the completed terrace serving as a model for the community in which it was built. County agents in the counties needing terraces were instructed in the methods of terrace location and construction and the levels used in this work were tested and adjusted by the engineers of the division.

The engineer also made preliminary examinations of drainage districts. The proposed district was visited, and from all available data that could be secured a report prepared, accompanied by a map, copies of which were furnished to interested parties. The methods of organizing a district under the State law were also outlined.

The following summary gives a brief account of the work done along those lines:

FARM DRAINAGE

During the past twelve months 45 farms situated in 23 counties have been visited for the purpose of giving assistance and advice in tile drainage. The area of these tracts covered by surveys and for which plans and reports for tile drainage were prepared covered a total of 1,206 $\frac{1}{4}$ acres on 24 farms. This does not include areas examined of which no survey was made or map prepared. Stakes and grades for tile drainage construction have been given on 10 farms in as many counties for the installation of 21,435 feet of tile. The amounts on individual farms ranged from 225 to 7,000 feet.

Sixty farms in 15 counties have been visited for the purpose of giving assistance in the location and construction of terraces to prevent hillside erosion, the total length of terraces laid out being approximately 86,115 feet or 16.3 miles, an average of 1,440 feet per farm.

DRAINAGE DISTRICTS

Nine examinations of a preliminary or reconnaissance nature have been made covering an area of 162,000 acres. The land covered by these projects is located in eleven counties in both the Piedmont and Coastal Plain regions of the State. On two of these no formal reports have been prepared, as the projects were found to be impracticable at the present; reports and maps for two more are being prepared; for the remaining five, full reports have been prepared and sent out to the interested landowners. Addresses were made at several meetings of landowners in which the State Drainage law and methods of organization were outlined.

MISCELLANEOUS

The results of experimental work and other information have been published from time to time in the "Extension Farm News" and other papers and publicity given in other ways. The annual convention of the North Carolina Drainage Association held at New Bern, N. C., was attended and addressed on the importance and benefit of tile drainage. Considerable correspondence was carried on with tile manufacturers in regard to the establishment of a tile factory in the State and an inspection trip made to two tile plants. A number of drainage districts in operation in the State were visited and a memorandum prepared on the conditions noted.

The various experimental projects under way during the previous year were continued, and a program and plan for a research project in soil erosion prepared. In connection with the latter, the staffs of the Divisions of Agricultural Engineering of Ohio State University, Purdue University, the University of Illinois and the University of Missouri were visited and consulted.

While less tile was installed during the past year than during either of the two preceding years, the number of requests for assistance received has been greater than in any other year, and the number of acres covered by surveys was greater than during 1922. The number of farms visited on terracing projects compares favorably with all prior years except 1921, when special effort was made to extend this branch of the work. The reduction in length of terrace laid out reflects the policy of the Division in promoting "less length but greater breadth" in terrace construction and the number of county agents and others who have been trained to carry on this type of work. Preliminary examinations of drainage districts exceed in number any year since 1915, except 1921, when the number was exceeded by two, and are the highest in acreage covered since 1914.

Respectfully submitted,

F. O. BARTEL,
Drainage Engineer.

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